NOTICE.

Future issues of this publication placed under either the "Special Veterinary" or "Special Forest Series" will not be included in the annual enumeration. Such papers are printed for Departmental purposes. Their unfortunate inclusion in the system of annual numbering has led recipients of the ordinary issues to think their sets incomplete.

The following pamphlets have already appeared as Special issues, and have not accordingly been furnished to the public.

1894 . . . Nos. 8, 9, 10, 11, 13 and 15.
1896 . . . No. 8.

(Veterinary Series, No. 26.)

THE

AGRICULTURAL LEDGER.

1898—No. 5.

OXEN.

(CATTLE DISEASES.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. V., O. 590-94.*]

PROFESSOR KOCH'S METHODS OF IMMUNISING CATTLE AGAINST RINDERPEST.

Reports by DR. A. LINGARD, *Imperial Bacteriologist to the Government of India,* VETERINARY-LIEUTENANT F. S. H. BALDREY, *Assistant Principal, Bombay Veterinary College,* VETERINARY-CAPTAIN W. R. HAGGER, *Principal, Ajmere Veterinary School,* VETERINARY-CAPTAIN H. T. PEASE, *Principal, Veterinary College, Lahore,* VETERINARY-CAPTAIN F. RAYMOND, *Superintendent, Civil Veterinary Department, Bengal,* VETERINARY-CAPTAIN G. H. EVANS, *Superintendent, Civil Veterinary Department, Burma.*

Other PAPERS that may be consulted:

Agricultural Ledger, 1894, Nos. 8 (Rinderpest*) and 13 (Cattle Disease*); 1896, No. 8 (Indian Cattle Plague*).

* Special Veterinary Series only.

CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1898.

The objects of THE AGRICULTURAL LEDGER are:—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

(Veterinary Series, No. 26.)

THE

AGRICULTURAL LEDGER.

1898—No. 5.

OXEN.

(CATTLE DISEASES.)

[*Dictionary of Economic Products, Vol. V.*, O. 590-94.]

PROFESSOR KOCH'S METHODS OF IMMUNISING CATTLE AGAINST RINDERPEST.

Reports by DR. A. LINGARD, *Imperial Bacteriologist to the Government of India*, VETERINARY-LIEUTENANT F. S. H. BALDREY, *Assistant Principal, Bombay Veterinary College*, VETERINARY-CAPTAIN W. R. HAGGER, *Principal, Ajmere Veterinary School*, VETERINARY-CAPTAIN H. T. PEASE, *Principal, Veterinary College, Lahore*, VETERINARY-CAPTAIN F. RAYMOND, *Superintendent, Civil Veterinary Department, Bengal*, VETERINARY-CAPTAIN G. H. EVANS, *Superintendent, Civil Veterinary Department, Burma.*

PREAMBLE.

Extract from the Proceedings of the Government of India, Department of Revenue and Agriculture,—No. 8/94-8, dated 5th May 1898.

Read—

Letters from the Inspector General, Civil Veterinary Department, Nos. 173—191, 755 C., and 218-114, dated, respectively, the 6th August, 13th November and 29th December 1897, submitting reports by the undermentioned officers on Dr. Koch's methods of immunising cattle against rinderpest.

Reports by Dr. A. Lingard, Imperial Bacteriologist to the Government of India; Veterinary-Lieutenant

F. S. H. Baldrey, Assistant Principal, Bombay Veterinary College; Veterinary-Captain W. R. Hagger, Principal, Ajmere Veterinary School; Veterinary-Captain H. T. Pease, Principal, Veterinary College, Lahore; Veterinary-Captain F. Raymond, Superintendent, Civil Veterinary Department, Bengal; Veterinary-Captain G. H. Evans, Superintendent, Civil Veterinary Department, Burma.

RESOLUTION.

When Professor Koch, the eminent Bacteriologist, visited India in the summer of 1897, he expressed his willingness to demonstrate the methods of immunising cattle against rinderpest, which he had practised during his investigations into the disease in South Africa. The Government of India gladly availed themselves of Professor Koch's generous offer, and arranged with Local Governments that the Imperial Bacteriologist and officers of the Civil Veterinary Department should attend the demonstrations which were to be carried out at the Bacteriological Laboratory at Muktesar in the North-Western Provinces. Professor Koch, accompanied by Dr. Lingard and Veterinary-Captain Pease, first visited some villages in the North-Western Provinces, where outbreaks of rinderpest had occurred, for the purpose of procuring material for his experiments, and then went to Muktesar, where he gave complete demonstrations of his system of immunisation.

2. The importance of these demonstrations can hardly be exaggerated in view of the great loss caused annually by rinderpest in India; and Professor Koch has placed at the disposal of the Government of India, in the freest possible manner, and at considerable personal inconvenience, all the results of his knowledge and experience of this most fatal scourge.

3. All the officers present at the demonstrations have submitted reports giving an account of the

RESOLUTION OF GOVT. OF INDIA.

methods adopted by Professor Koch, and as these contain many valuable suggestions, it has been decided to publish extracts from them in the Veterinary Series of the Agricultural Ledgers. The Government of India also consider it desirable that the attention of Local Governments should be specially directed to certain points in the reports which are deserving of special notice.

4. The report of the Principal of the Lahore Veterinary College shows that Professor Koch's method could not well be utilised in the case of outbreaks in the districts in view of the fact that his process of immunising takes quite ten days, and that before this time had elapsed an animal exposed to contagion would be likely to contract the disease. This is a matter of no small importance, but it is believed that more practical methods are already being adopted in South Africa, and experiments are now being carried on by the Imperial Bacteriologist which, it is hoped, will result in the discovery of a method more suited to the requirements of this country. But meanwhile the Government of India ask for the hearty co-operation of Local Governments and Administrations in the carrying out of experiments in different parts of the country, more especially in the districts in the plains. The necessity for such experiments is clear, whilst the account of the experiments carried out by Veterinary-Captain Raymond in Bengal shows how much can be done by officers possessing the necessary qualifications. Sindh would also appear to be a favourable field, and the Government of India will be glad if it is found possible to make experiments there. The Government of India feel assured that Local Governments will encourage experiments wherever it is possible to carry them out by properly qualified agency and without the risk of creating new centres of infection.

5. Another point which is of special importance with reference to the hide trade of India is referred

OXEM. Professor Koch's Methods of

RESOLUTION OF THE GOVERNMENT OF INDIA.

to in the report of the Principal of the Lahore College. Veterinary-Captain Pease shows how hides may be rendered inert, and his recommendations on this subject appear to be well worthy of careful consideration.

Government of Madras.
" Bombay.
" Bengal.
" North-Western Provinces and Oudh.
Government of Punjab.
" Burma.
Chief Commissioner, Central Provinces.
Chief Commissioner, Assam.
" " Coorg.
" " Ajmere-Merwara.
Resident, Hyderabad.

ORDER.—Ordered, that a copy of the above Resolution be forwarded to the Local Governments and Administrations noted in the margin, for information.

Ordered also, that a copy be forwarded to the Inspector General, Civil Veterinary Department, for information.

[True Extract.]

DENZIL IBBETSON,

Secretary to the Government of India.

---

1. In accordance with the foregoing Resolution of the Government of India, the following Reports, or Extracts from Reports, are now printed.

2. Dr. Lingard, the Imperial Bacteriologist, reports as follows:—

DR. LINGARD'S REPORT.

In accordance with your deferred telegram, dated Simla, 5th May, 1897, received by me at Jainti, Hathipoda, North-East Bengal, at 5 P.M. on May 9th, 1897, I started for Bombay on the same date at 7 P.M., and arrived on May 16th.

2. On receipt of your letter No. 474—191 M., with instructions, I at once placed myself in direct communication with Professor Koch.

The outcome of our several meetings was that Professor Koch kindly offered to demonstrate the steps of his protective system against rinderpest in cattle, if he might be allowed to obtain the material at the seat of an outbreak of the disease and conduct his demonstrations at Muktesar Laboratory.

3. After having informed you by wire of the Professor's proposals, I followed out your instructions to obtain information concerning outbreaks of rinderpest as near as possible to the Laboratory.

For this purpose I put myself in communication with the Superintendent, Civil Veterinary Department, North-Western Provinces, and later ascertained that outbreaks of the disease were present in the districts of Barabanki and Fyzabad (Partabgarh and Akbarpur). Permission by wire having been obtained from His Honour the Lieutenant-Governor of North-West Provinces.

4. After making the necessary arrangements in Bombay, Professors Koch, Gaffky and Pfeiffer left Bombay with me on the 26th of May and proceeded at once to Lucknow, where we arrived on the 28th. From this station telegrams were despatched to different District Officers, and information received as to the best locality to visit for our purpose. On the morning of the 30th May, in consultation with the district authorities at Fyzabad, we left Lucknow for that station with a view to visiting Akbarpur, where a rinderpest outbreak had been reported to exist.

Information having been received by the Deputy Commissioner during the day, concerning cattle disease in the Akbarpur Tehsil, tents and other necessaries were despatched by his orders to Akbarpur to await our arrival on the following morning.

5. On the 31st we proceeded by rail to the above station. The Veterinary Assistant of the district met us there, and informed us that rinderpest was supposed to be present in the villages near Tanda, some 12 miles distant. And after corroborating the same, we made arrangements for leaving the station early on the following morning.

6. On our arrival at Tanda on June the 1st, the Veterinary Assistant was despatched to visit certain villages with a view to discovering cases of the disease. On his return with information as to the presence of cattle plague, we proceeded to the village of Rajipura and there found several head of cattle and buffaloes suffering from rinderpest and the carcases of one which was said to have succumbed about half an hour.

Professor Koch made the autopsy on the animal, and subsequently expressed it as his opinion that "the pathological changes found

[illegible] Colony's Report.

in the intestines, were identical with those found by him in animals dead of rinderpest in South Africa, and therefore the Indian and the South African diseases are identical." At the same time the Professor collected blood from the heart in sterilised flasks, which he defibrinated *in vitro*. He also collected bile from the gall bladder into similar vessels. These vessels were subsequently placed in ice.

Early on the following morning we again visited the same and other villages with a hope that we might obtain another autopsy; however, as no animal had succumbed to the disease during the night, we collected specimens of nasal and lachrymal discharges, together with small quantities of fæcal matter and mucus passed, respectively, by a buffalo and a bull, suffering from rinderpest.

On our return the whole of our specimens were deposited in a tin box which was surrounded entirely on all sides with thick slabs of ice, and we proceeded to the Laboratory at Muktesar with the utmost despatch.

7. The conclusions * Professor Kooh arrived at, at the termination of his experiments with regard to rinderpest in South Africa, were as follows:—

(*a*) The best method of transmitting rinderpest from one animal to another is by means of subcutaneous injection of virulent defibrinated blood, for by this means blood can be taken from animals during the earlier stages of the disease, when it does not contain any septic matter, but simply the contagium of rinderpest. Another great point in favour of using virulent rinderpest blood for the above purpose, is the important fact that a form of disease is produced with an incubation period of from three to five days.

(*b*) One five hundredth of 1 c.cm. of virulent rinderpest blood produced rinderpest in an animal after exactly the same time and manifested the same malignant symptoms as those animals which had received 10 c. cm., a dose 5,000 times larger. And later Professor Kooh heard from South Africa that the inoculation of $\frac{1}{10000}$th of 1 c. cm. of blood had produced a like result.

(*c*) Glycerine, when mixed with virulent rinderpest blood, exercised a destructive effect upon the rinderpest virus.

(*d*) Distilled water, mixed with virulent rinderpest blood, delayed the symptoms of the disease, but later the symptoms appeared and the disease was just as violent and fatal as in the ordinary spontaneous cases of rinderpest.

(*e*) Virulent rinderpest blood is destroyed by prolonged exposure (four hours) to a temperature of 31°C. (87·81°F.); when injected into cattle, however, it produces "no protective action."

* Collated from Professor Kooh's *interim* reports published in South African newspapers.

Immunising effects of Bile.

8. Immunity from rinderpest is conferred upon cattle after the subcutaneous injection of 10 c. cm. of bile taken from the gall bladder of an animal which has succumbed to a virulent attack of rinderpest.

"This immunity sets in on the 10th day at latest, and is of such an extent that even four weeks afterwards 40 c. cm. of rinderpest blood could be injected without any injurious result. I therefore conclude that the immunity produced in such manner is of an '*active*' nature."

Experiments, however, have proved that an injection of less than 10 c. cm. rinderpest bile is insufficient to render cattle immune against rinderpest.

"The local result of an injection is merely a hard, somewhat painful, swelling of the size of a man's fist, which sometimes causes lameness for a few days, but gradually disappears in the course of a few weeks, provided, however, that the bile is not in a stage of decomposition, as is not uncommon, when an animal suffers from rinderpest. Under these circumstances, an abscess may form, which, however, does not seem to be detrimental to the process of immunisation."

"The protective properties of the bile will be of inestimable service in infected parts. Nearly every case of rinderpest supplies a greater or lesser quantity of vaccine for those animals which are still healthy."

9. Regarding the immunisation from rinderpest, Professor Koch remarked, "I undertook many experiments for the purpose of ascertaining the best manner in which the bile is to be employed, and to investigate the nature of this remarkable process."

"First, a control experiment was made with the bile of a sound animal. The result was, that such a bile had no immunising effect whatever. Also the bile of an animal suffering from rinderpest is as such by no means effective when taken from a rinderpest animal, that was killed on the 3rd day after the observed rise of temperature, and did not protect the injected animal against the disease. Even the bile from animals which survived the attack of rinderpest proper, but were suffering from secondary disease and died from such causes, was of a very doubtful or no protective value. The best results I always obtained were with bile as used at 'Susanna' farm and the qualities of which I characterised in my description of these experiments."

"For theoretical reasons I made an experiment by mixing larger and smaller quantities of virulent rinderpest blood with the rinderpest bile and thereby got the important result that the bile is able to make a considerable quantity of rinderpest blood innocuous, provided both fluids are properly mixed. In one case 5 c. cm. bile and 5 c. cm. blood were injected and the animal became immunised by this treatment."

"It appears that an admixture of rinderpest blood with rinderpest bile even increases the immunising qualities of the latter, and I do not consider it improbable that less effective rinderpest bile, *i.e.*, bile taken from the animals at the beginning of the disease, may be transformed in this way into an effective medium, and that even the bile of sound animals might be used by such a process for the same purpose. Experiments in connection with the hypothesis are not ended as yet, and the matter is at present only in a state of investigation. Should these experiments give a good result, it would then be an easy matter to prepare at any time large quantities of a highly immunising and uniformly acting protective medium. In practice, these experiments are so far of importance, as is herewith clearly proved, that contamination of the bile with blood must by no means be scrupulously avoided."

10. "Four animals were injected with 10 c. cm. of bile taken from an animal that had died at the 'Susanna' farm. Of these, No. 1 was re-injected with virulent blood on the second day after the first injection. No. II on the fourth, No. III on the sixth, No. IV on the eighth day after the first injection."

"No. I fell sick and died, as if no protective inoculation had taken place.

"No. II fell sick with slight symptoms of rinderpest, but soon recovered.

"No. III and No. IV exhibited no symptoms of any disease whatever. They proved themselves so strongly immunised that a subsequent injection of 20 c. cm. of fresh rinderpest blood produced no reaction of any kind. In accordance with these facts, the conclusion may be drawn that immunity began on the sixth day after the application of this bile."

11. "To ascertain whether smaller doses like 10 c. cm. were sufficient to create immunity, I injected three cattle with 1, 2 and 5 c. cm. of rinderpest bile each, and applied ten days later 0·2 c. cm. rinderpest blood. All these animals fell sick subsequently with severe symptoms of rinderpest, one inoculated with 5 c. cm. recovered, the other two died; it may, therefore, be concluded with safety that an injection with less than 10 c. cm. rinderpest bile is insufficient to render cattle immune against rinderpest."

Immunising power of injections of Blood serum from Rinderpest Animals.

12. "The protective properties of blood serum are not very great, for 100 c. cm. of such serum are required to protect an animal against an inoculation with a small dose of rinderpest blood. This immunity is in its nature merely a 'passive' one, and will only last during a short period."

"This method may be used in order to separate from infected areas those tracts of country which are still free from the scourge, by means of forming a broad belt between them in which all the cattle are inoculated with the vaccine."

"For protective inoculation on a large scale the above serum is not applicable, but by means of a mixture of *serum and virulent rinderpest blood* I succeeded in immunising within a fortnight several animals to such a degree, that they were enabled to withstand an injection of 20 c. cm. rinderpest blood $\frac{1}{1000}$th part of which is a fatal dose."

"From this fact, I judged that the immunity of these animals is of a much higher degree, and I believe it is an 'active' immunity, equal to that of a beast which has contracted rinderpest and recovered."

13. "To prepare the above serum from 'salted' animals, the blood is taken from the jugular vein and is conveyed into an air-tight bottle. It is then allowed to remain for 24 hours in a place kept as cool as possible and not disturbed. The fibrin and serum will then be found to have formed."

"The latter is to be taken off with a syphon and mixed immediately with fresh rinderpest blood in the proportion of 1 : 100 c. cm., *i.e.*, for each 99 parts of serum one part of fresh blood. This mixture is kept for about 12 hours in a place at the usual temperature and is shaken from time to time. After the lapse of this time, the animals to be rendered immune are injected into the dewlap with 20 c. cm. of this mixture. In this way a certain basis of immunity is obtained. Although considerably less effective than the gall injection, the state of immunity may soon be raised by further injections with blood. For this purpose I gave on the seventh day after the first injection, 1 c. cm. and again seven days later 20 c. cm. of fresh blood. To preserve this serum for a certain time with all its immunising qualities, I did unfortunately not succeed, except by keeping it in the ice box."

14. "Should the necessity arise to employ the serum in a preserved state, there will be no other way but to dry it in the vacuum apparatus, a treatment which gave most satisfactory results with other kinds of serum."

Method of collecting Bile.

15. The autopsy should be held on the 6th * day or as soon after the animal succumbs to rinderpest (seventh or eighth day) as possible.

16. The animal is laid on its left side, an incision is made in the flank from the vertebral column down along the posterior border of the ribs, and from thence posteriorly along the median line of the abdominal wall. After carefully opening the peritoneal cavity at one point, insert the fingers of the left hand and cut through the abdominal muscles along the line, before indicated; at the same time raising the tissues to avoid wounding the organs with the knife. On reflecting the above flap, the gall bladder will be exposed to view.

An Assistant, whose hands have been previously washed in sublimate solution (1 in 1,000), takes hold and raises with his left hand

* In South Africa Professor Koch slaughtered rinderpest animals for bile on sixth day of the disease.

the free border of the ribs, while with the right he grasps the gall bladder, placing the palm of the hand under it, and by gentle pressure forces the contained fluid towards the fundus of the organ. The person about to collect the bile should make a small vertical incision with a sterilised scalpel at the most dependent part of the bladder, and so allow the bile to flow into a sterilised vessel, fitted with glass stopper or cotton-wool plug.

After collection, the bile should be placed in an ice chest or cool cellar, until required.

Operation necessary for the collection of blood from the jugular vein of an Animal.

17. The animal is thrown down in the usual manner, the feet being securely fastened together. A block of wood some 5 or 6 inches in thickness is placed under the neck in order to raise and extend the skin over the seat of operation. The exact spot for the incision is found by bending over the ear along the course of the jugular vein, the incision being made at the point where its tip reaches. After cleaning the surface of skin and washing it with a solution of sublimate (1 in 1,000), pressure is put on the jugular vein, low down in the neck, when the course of the vessel comes rapidly into view. An incision 1½" long is made through the skin transversely to the axis of the vein at the above-mentioned spot. An electro-plated canula is then pushed gently through the wall of the vein and the blood is caught in sterilised flasks. On withdrawal of the canula slight pressure is exercised for several minutes, with a pledget of cotton-wool saturated with sublimate solution, after which, as a rule, all hæmorrhage ceases. One or two sutures are then placed in the skin wound, and after thoroughly washing the surface of the skin, the animal is removed.

Injection of Bile or Blood.

18. The animal is thrown down in the usual manner, and the four feet securely fastened. A portion of skin selected to receive the injection, covering the anterior extremity of the sternum or of the dewlap, is grasped between the fore-finger and thumb of the left hand and slightly lifted up from the underlying tissues. The needle of the syringe containing the fluid to be injected is then inserted into the depressed skin between the tips of the finger and thumb, and with a boring motion, if from the thickness of skin any difficulty in piercing it is experienced. Care should be taken that the needle passes into the subcutaneous tissues and not into the underlying muscle. It is always as well to feel that the needle is free, before forcing the bile or blood, from the injection syringe. When removing the needle, still retain hold of the integument with the left fore-finger and thumb, and, after withdrawing it, grasp the skin at the point of exit of the needle with the right hand, whilst with the left manipulate the small subcutaneous tumour with a view to the dispersal of the injected fluid.

19. Having now given the results obtained by Professor Koch and the technique of the different operations, it is necessary to enumerate the requirements in order that use may be made of the bile protective system :—

(*a*) Virulent rinderpest material.
(*b*) Inoculation of animal for bile.
(*c*) Injection of bile into animals.
(*d*) Animals undergo proof with virulent rinderpest blood.

(*a*) Virulent rinderpest blood is required for the inoculation of cattle in any district, unless the disease already exists in a virulent form.

(*b*) Inoculation of animals with rinderpest blood, in order that they may pass through the malady and be destroyed on the proper day of the disease, for the purpose of collecting bile. If the operation is postponed until directly after the death of the animal, the bile can only be utilised when obtained from those animals which succumb to a virulent attack on the seventh or eighth day, but not later. The best bile when drawn from a rinderpest animal dead of the disease presents a green colour and few, if any, micro-organisms. Frequently, however, this fluid is found to present a yellowish green or brownish green appearance by transmitted light, and it is then generally found not to possess the high immunising power of the green bile and microscopically, more septic organisms.

The best bile for protective purposes found by Professor Koch in South Africa was that obtained on the sixth day after the rise of temperature, and from this he proved that bile (aseptic at time of collection), when kept in ice, preserved its protective power for a period of 14 days; in fact, its immunising power, when injected into animals, was found to be just as high at the end of the 14 days as at the time of collection.

(*c*) Inoculation of animals with approved bile—Ten cubic centimetres is the smallest amount which should be injected into each animal, and all bile should be carefully examined microscopically and any micro-organisms found in the fluid noted, not only as soon after collection as possible, but before using it at any later date, for, considerably more swelling takes place at the seat of injection with bile which contains organisms when collected directly after death, and which is kept for subsequent inoculation purposes.

(*d*) It is essential that animals injected with bile for protective purposes, should be proved by inoculation of virulent rinderpest blood at a later date.

Previously it has been pointed out that the immunity conferred by the injected bile sets in on the tenth day at latest in South Africa, and therefore this day was chosen for the proof experiment.

RESULTS OF EXPERIMENTS UNDERTAKEN AT MUKTESAR, 7,500 FEET ELEVATION ABOVE SEA-LEVEL.

20. With the rinderpest material brought from Tanda it was the intention, if possible, (*a*) to reproduce the disease by inoculation of

blood, in order to obtain a supply at a later date for proving the immunising power of the bile; (*b*) to reproduce the disease with nasal discharge and dung; (*c*) to protect animals against rinderpest by the subcutaneous injection of bile, and other modified processes.

The following précis of the cases will show the course the disease followed in the animals inoculated.

Blood.

21. Immediately on our arrival at the Laboratory on June 4th, 7 P.M., two bullocks, Nos. I and II, were each inoculated in the dewlap with 10 c. cm. of the defibrinated blood.

No. I.—This animal's temperature attained 104° F. on the fourth day after inoculation and 105·8° F. on the evening of the sixth. Severe symptoms set in—purging, etc., and death took place on the morning of the tenth day from the time of inoculation.

On the fifth day of the disease with a temperature of 105° F. blood was let, and two animals, Bull No. XI and Cow No. XII, were inoculated with 10 c. cm. each. The *post-mortem* disclosed the usual marked pathological changes found in rinderpest.

No. II.—The temperature rose to 104° F. on the evening of the fourth day and to 105·6°F. on the seventh day after inoculation. This animal presented all the well-marked symptoms of rinderpest, but instead of death following a rapid fall in the temperature on the seventh and eighth day of the disease, death took place on the sixteenth day after inoculation. A gradual fall in the temperature, from 104·7°F. to 91·6°F., when death occurred, occupied eight days.

No. XI.—Was inoculated with 10 c. cm. of blood drawn from the jugular vein of No. I on the 11th June. The temperature rose somewhat suddenly to 105·8°F. on the 15th and attained the maximum 106·5°F on the 19th, the fourth day of the disease. This animal passed through a smart attack of rinderpest, the temperature falling to normal on the seventh day of the disease; but up to this blood was still passed with the dung. The animal has now recovered. No. XIX Bull was inoculated on the 21st June with blood drawn from the jugular vein of No. XI.

No. XII Cow.—First rise fourth day after inoculation; recurrent fever until morning of the seventh day of disease. Temperature normal. This animal passed through a very smart attack of the disease 'diarrhœa,' cough being a most troublesome symptom; mucus and blood still passed on the fourteenth day of the disease, July 11th; has now recovered.

No. XV Buffalo.—This experiment was made with a view to discover what course rinderpest takes in the Buffalo, and when inoculated from bovines, whether the virulence of the disease is increased or diminished. It was inoculated with 10 c. cm. of defibrinated blood taken from the heart of Bullock No. I at *post-mortem*, and inoculated five hours after death. A slight thickening occurred at the seat of inoculation, but it had entirely disappeared after 24 hours. The rise in temperature did not occur until the

eighth day after inoculation; maximum 105·8°F. attained on second day of disease, and normal temperature again recorded on the 4th day of the disease. A trace of blood and mucus was passed 'per anum' at the time of the first rise in temperature, but only slight diarrhœa followed, and the animal was never entirely off its feed. This animal was inoculated as control to cases Nos. V and VI, first inoculation with bile.

Blood was taken from the jugular vein on the 25th June, and 10 c. cm. inoculated into No. XXII.

No. XIX Bull—Inoculated with 10 c. cm. blood taken from the jugular vein of Bull No. XI, *ante-mortem*. This animal presented a few symptoms of rinderpest, *viz.*, shivering, high temperature on two occasions, blood-stained dung, etc., but the attack was only very slight and the animal was never off its feed. This animal was inoculated as a control experiment to Cows Nos. VII, VIII, IX and X on the 21st June 1897.

No. XXII Bull—Was inoculated on June 25th, 1897, with 10 c. cm. of blood taken from the jugular vein of Buffalo No. XV. The temperature began to rise on the fourth day after inoculation and attained a maximum of 107·9°F. on the fourth day of the disease, after which it declined; by the 7th day of disease, registered 99·7°F. Dullness and loss of appetite were the most marked symptoms, but the attack of rinderpest was very slight.

Bile.

22. On June 6th, 1897, at 4-30 P.M., two animals, Cow No. V and Bull No. VI, were each injected with 10 c. cm. of bile collected from an animal which succumbed to rinderpest, near Tanda, at 7 P.M. on June the 1st, and therefore 120 hours old. On the 14th June at 5 P.M. each animal received subcutaneously 10 c. cm. of defibrinated blood taken from the heart of Bullock No. I, in order to prove whether the injected bile had conferred protection against rinderpest.

No. V Cow.—On the 19th, the sixth day after inoculation with blood, the animal appeared dull, coat staring, and the following day shivering supervened. The temperature on the 21st evening attained its highest, *viz.*, 105·6°F. and then commenced to fall, afterwards running within normal limits.

No. VI Bull.—The temperature of this animal never exceeded the normal limits after inoculation with blood on the 14th June, and no symptom was noticed until 5 P.M. on June 27th, and then only a little mucus and blood was passed with the dung, followed by a few drops of blood later, the animal was never off its feed.

At the time of the inoculation with blood on the 14th June, Buffalo No. XV was also injected with 10 c. cm. of rinderpest blood to act as a control experiment; but, as will be seen, this animal only passed through a slight attack of rinderpest, and therefore the experiment proves nothing.

23. On June 10th (A.M.) a second series of animals (Cows VII, VIII, IX and X) were injected with 10 c. cm. of bile, taken from a

rinderpest Bull, near Tanda, at 7 P.M. on June 1st, 1897, and therefore utilised about 207 hours after collection or *post-mortem*. No rise of temperature was recorded in any of the four animals during the next ten days; so, on the morning of the 21st June, each animal was injected with blood in order to prove whether any protective influence had been conferred by the previous injected bile.

No. VII received 10 c. cm. of blood taken from the jugular vein of Bull No. XI; No. VIII, a like quantity, whilst Nos. IX and X only received 0·2 c. cm. of blood from the same animal, mixed with physiological salt solution.

The following are the principal symptoms noted in each of the four cases:—

No. VII.—Passed through a slight attack of rinderpest, but the only points noted were: a swelling the size of a cricket ball at seat of inoculation, hot but not tender, shivering on the 24th and 25th and later, dung watery with mucus and a trace of blood; the temperature during the next 14 days scarcely exceeding normal limits. On the 27th fluctuation was felt at the seat of inoculation, and on the 29th, a small white coagulum escaped from the wound, which quickly healed.

No. VIII.—Temperature was never raised above normal limits during next 14 days, although there was a swelling as large as a man's fist at the seat of inoculation, hard and hot, but not tender on manipulation. No diarrhœa or symptoms of rinderpest were observed.

No. IX.—This animal and No. X received only $\frac{1}{10}$th amount of rinderpest blood injected subcutaneously into Nos. VII and VIII; nevertheless, No. IX after 24 hours presented at the seat of inoculation a swelling 3 inches in diameter, hard, hot and tender, which increased on the following day to a ball 4 inches in diameter. For six days after inoculation the temperature did not rise, but on the seventh day, *viz.*, 27th June, it registered 104·4°F. and continued high until the evening of the 2nd July, when it attained a maximum of 108·5°F. It was only during the period the temperature was exalted that the animal appeared dull and left off feeding. On the morning of the 4th July, the thermometer registered 99·5°F., a difference of 9°F.

This animal was very ill, suffered from hyper-pyrexia, but the symptoms of rinderpest were not marked.

No. X.—Presented a hard, hot and tender swelling, 5 inches in diameter, at the seat of inoculation; the tenderness gradually disappeared a few days later. The temperature never exceeded normal limits during the next 14 days, and no symptoms of rinderpest presented themselves.

The control Bull No. XIX, inoculated with rinderpest blood, taken from the jugular vein of No. XI, passed through a very slight attack

of rinderpest, but did not succumb to the disease. Consequently, although the Cows VII and IX had slight attacks of the disease, animals VIII and X presented no symptoms of rinderpest.

24. The experimental researches commenced at this Laboratory by Professor Koch on June 4th, 1897, were undertaken with a desire to demonstrate his methods to the gentlemen assembled for that purpose, and at the same time to ascertain whether the means he discovered for immunising cattle against attacks of rinderpest in South Africa by the subcutaneous injection of bile and other body fluids, derived from such diseased animals, would prove as efficacious in protecting Indian cattle.

25. It will be as well first to consider what results we should have expected, if the Muktesar experiments coincided with those made in South Africa.

Animals inoculated with Rinderpest Blood.

The majority, 90 per cent. of animals inoculated with rinderpest blood, should have shown an abrupt rise in temperature on the third to the fifth day after inoculation, followed by the usual severe symptoms, viz., purging, dysentery, etc., death taking place on the seventh, but not later than the eighth, day of the disease. A certain percentage, about 10, after passing through a serious attack of the malady, should have recovered.

Animals inoculated with Rinderpest Bile.

All the cattle subjected to the injections of bile obtained from rinderpest animals should have presented, merely a hard, somewhat prominent and painful swelling, of the size of a man's fist, perhaps slight lameness for a few days, in some cases, but which would gradually disappear in the course of a couple of weeks, provided, however, that the bile was not in a state of decomposition, as is not uncommon when an animal suffers from rinderpest. During this period there should have been little or no constitutional disturbance.

Bile-injected animals afterwards proved with Rinderpest Blood.

After a period of ten days the bile-injected animals should be subjected to inoculation with a varying amount, generally 10 c.cm. each, of virulent rinderpest blood, in order to ascertain whether any protection had been conferred upon them individually. If this has been the case, during the above period no untoward symptoms would have been observed on examination of the animals, and their temperatures would have remained within normal limits, feeding, etc., as in health.

Healthy animals inoculated with Rinderpest Blood as a control.

But completely otherwise would have been the condition of the healthy animals inoculated with a portion of the same blood as that used for proving the bile ones. The ordinary symptoms of rinderpest should have supervened and death followed in the majority of cases on the seventh or eighth day of the disease.

26. Now let us see what course the disease followed in the animals inoculated with rinderpest at Muktesar.

Nos. I and II were inoculated by Professor Koch with defibrinated blood from Tanda. No. I—temperature rose on the fourth day, and later severe symptoms set in with loss of appetite, dulness, purging and dysentery; and this animal succumbed to a typical attack of virulent rinderpest on the seventh day of the disease.

No. II.—The temperature rose as in the case of No. I on the fourth day, and later the animal presented all the well-marked symptoms of the disease; but instead of death occurring on the seventh or eighth day, it did not take place until the thirteenth day of the disease. So that instead of the animal dying from rinderpest it probably succumbed to a secondary infection.

On the fifth day of the disease, when the temperature was high and the symptoms of rinderpest well marked, blood was taken from the jugular vein of No. I and the usual quantity was injected into Nos. XI and XII. These animals passed through fairly smart attacks, but in both instances a normal temperature was recorded on the seventh day of the disease and the animals made an uninterrupted recovery.

On the 14th June blood was taken from No. I (*post-mortem*), and two animals were inoculated, *viz.*, Cow No. V and Bull No. VI. These had been previously injected with bile from Tanda. The effects of these inoculations were that the cow suffered from a comparatively slight attack of rinderpest from which she recovered in a few days, while the bull showed no symptoms whatsoever. The unprotected control animal inoculated with blood from the same source, which should have succumbed, or, at all events, had a very severe attack of the disease, only had a slight illness, no symptoms being manifest until the eighth day after inoculation and then only lasting 48 hours.

The other unprotected animals inoculated were No. XIX from blood taken from No. XI. In this case, if the disease was present, it must have been of the slightest character. No. XXII, inoculated with blood from No. XV, only passed through a mild attack of rinderpest, but although the temperature recorded was very high, the symptoms were poorly marked.

From the above it will readily be observed how the virulent rinderpest blood, which at first produced death in the usual time, and accompanied by well-marked symptoms of the disease, when inoculated into other animals, gradually lost its power of re-producing rinderpest, and finally became so attenuated that it almost failed to produce any symptoms at all.

DR. LINGARD'S REPORT.

27. The following table shows in tabular form the different animals inoculated with *ante* and *post-mortem* blood derived from Bull No. 1, which was injected with rinderpest material, 73 hours old, from Fyzabad District:—

Blood obtained from Tanda.

No. 1.

Typical	Rinderpest.
Very	severe.
Ante-mortem blood	*Post-mortem* blood.
drawn from Vena jugularis.	drawn from *Heart*.

Smart attack. XI.	Smart attack. XII.	Slight attack. V.	Slight attack. VI.	Slight attack. XV.	
No typical symptoms. XIX.				Very mild. XXII.	

28. From information kindly communicated by Professor Koch concerning the course of rinderpest in South Africa, it appears that the disease, both when acquired spontaneously and after inoculation, runs its course in a definite number of days, *viz.*, 7 to 8. In the event of an animal dying at a later date than the above, death is frequently not due to true rinderpest, but to a secondary infection, frequently caused by a distinct species of micro-organism (Streptococcus).

In South Africa the temperature of the inoculated animal, which generally remained up to the fourth or fifth day within normal limits, rose abruptly to 104°F. or over, remaining high up to the evening of the sixth day of the disease, when it rapidly declined until death supervened.

Of the seven animals inoculated at Muktesar with rinderpest blood, two only died, those being Bullocks, No. I and II, which were inoculated with blood directly brought from the case at a village near Tanda. The other five recovered after attacks of rinderpest varying in intensity.

29. To account for the severe type of disease found in South Africa, we must remember that the outbreak in that country was a new malady, affecting the animals of a country which had not been previously attacked by a like epidemic in the memory of man, and therefore spreading over 'Virgin Soil,' as in the case of measles in 1874 introduced from Sydney, when one-fourth of the inhabitants of the Fiji group were carried off. Numerous like instances with regard to other diseases, *e.g.*, small-pox, syphilis, etc., might also be added.

The symptoms observed as a consequence at the Cape were of a far severer type and the mortality greater (90 per cent.) than that generally observed in the plains of India. In the Himálayas, however, the mortality amongst cattle suffering from rinderpest reaches 95 per cent., or even 98 per cent. in exceptional epidemics.

In the plains of India, the mortality from rinderpest may frequently be observed to be very slight, varying from 25 to 10 per cent. Probably several causes may be put forward to account for this attenuated form of the disease, but at the same time it must not be forgotten that although rinderpest may go smouldering on, attacking only very few of the cattle of a certain district, and those with a mild form of the disease, nevertheless, without any warning, a most virulent form of rinderpest may break out and be accompanied by a high mortality.

30. *Breed.*—May perhaps in some instances bring about a certain amount of immunity against cattle plague, for it is well known that Pasteur proved Algerian sheep immune against anthrax, although French sheep readily succumbed after inoculation with the same virus.

31. *Immunity.*—In India and the East rinderpest has been existant probably for hundreds of years, and it is extremely difficult to ascertain in such a vast extent of territory, what immunising effect may have been acquired by some of the cattle of this country. It is probable, however, that in some districts the cattle have received a certain amount of protection against rinderpest through their progenitors, but up to the present this has been impossible to estimate. At the same time, young cattle frequently succumb to a virulent form of the disease even when older cattle in the same district are little affected by the epidemic, and when these latter have not been known to suffer from the malady even in a mild form. It is well known, however, that an animal may be attacked with so slight a form of rinderpest that it may even be overlooked by the initiated in this disease.

Influence of Heat on the virus of Rinderpest.

32. The most potent cause of the attenuation of rinderpest amongst the plain cattle of India, we should imagine, is due to the influence of the higher temperature to which the virus is exposed during the hot season. Observers, long before Professor Koch studied rinderpest, have pointed out that the virus of this disease may be destroyed by exposure, for a short time, to a temperature far below that found in the direct rays of the sun during the hot season on an exposed plain in India; but Professor Koch has lately shown in South Africa that the virulent blood from a case of rinderpest may completely lose its virulence after being exposed to a temperature of 87·8° F. for four hours. From this it would appear that if a *post-mortem* on a rinderpest animal were conducted in the open, and the ground besmeared with blood, nevertheless after a period of four hours (during three-fourths of the year) no infection would follow, if animals were kept off the infected area until the above time had elapsed.

Attenuation of the Muktesar virus.

33. In the present state of our knowledge, it is impossible for us to give a satisfactory explanation of the causes which led to so rapid an attenuation of the rinderpest virus, as that which occurred when animals were inoculated with material brought up to the hills (7,500 feet elevation) from the plains. The animal, nine years of age, first to be inoculated, was bred and born in the plains, but of late years had been kept in the mountains. This animal died of a typical well-marked rinderpest in exactly the same time as was found in South Africa. But in the later inoculations the disease proved abortive, both in plain and hill cattle. We recognise, however, the fact that the period of the year (June), when these experiments were undertaken, was the very worst possible one, for obtaining virulent rinderpest in the plains.

Those who have observed the changes in the virulences of rinderpest during the different seasons of the year, recognise that the virus becomes least potent in its action, at the end of a hot season, when the disease simply smoulders through the cattle of the low country, causing a mortality of not more than 5 per cent.

We must not forget also that the months of May and June 1897 were the hottest part of an exceptionally torrid season. In addition, it is a well recognised fact that in every severe epidemic, whether attacking human beings or animals, the mortality is always greater at the commencement of an outbreak of disease, than towards its termination, when cases generally recover without any treatment.

Further, Kooh has made a special point of the fact that in order to transmit rinderpest successfully, blood should be taken from the infected animal during the earlier stages of the malady, when it does not contain any septic organisms, but simply the contagium of the disease. The greatest difficulty, however, was experienced by us in finding any cases of rinderpest at all, in the Fyzabad District, so that the only virus obtainable for conducting investigations at Muktesar, had to be collected from the heart of an animal which had succumbed to rinderpest more than half-an-hour, before the autopsy was made. To one or more of the above causes, therefore, must be ascribed the cause of the attenuation of the rinderpest virus, which will have to be guarded against in future experiments.

Objections to the method.

34. (i) The greatest difficulty is the fact that the bile does not keep at ordinary temperatures of the air, and that according to Kooh only green biles can be used for protecting cattle. But green biles are only obtained rarely, the most frequent proportion being one in seven.

(ii) In this country where the cattle are small, 150 c. cm. (5·27 ozs.) of bile is all that one can hope to obtain from an animal, whereas in South Africa Professor Kooh stated the amount averaged 500 c. cm., but that it was not at all unusual in large cattle for him

Dr. Ludwig's Report.

to obtain 1,000 c. cm., equivalent to about 35 ounces. As in Africa only 50 animals can on the average be inoculated from the bile of an animal (500 c. cm.), it follows that one rinderpest animal is required under the best conditions to inoculate seven animals. In this country (India), therefore, where 150 c. cm. of gall is the highest amount obtainable from one case, one rinderpest animal would only prove sufficient to inject 2·14 head of cattle.

(iii) It would be an easy matter to follow out this method of protection in districts where rinderpest already exists, but in case animals have to be protected in parts of the country where no disease is then present, virulent material would have to be transported to the scene of inoculation and animals inoculated, in order to provide bile in sufficient quantity. This is a serious objection to the method, but as a considerable number of investigations must be carried out before this system can come into general use, some modification in method may probably be discovered.

35. On the other hand, a very good instance of the great utility of the bile method is taken from Koch's experiments on a farm 'Susanna' on the Free State Border—

"Rinderpest broke out on the 20th January on the farm of Mrs. Lisching. In this case, as in so many others, the introduction of the epizootic was due to the intercourse of the Kaffirs with other natives belonging to infected farms. On the 2nd February 1897, 180 head of cattle were much infected; 29 cattle which appeared sound and had been kept separate were injected with bile which was taken from an animal that had died the day before of rinderpest, after a sickness of six days. This bile had a dark green colour, was almost clear, and had the same smell as bile from a sound freshly-killed animal."

"All the animals injected with bile showed more or less prominent swellings at the point of injection, and, as a consequence, some were lame for a few days. These swellings went down in the second week and soon disappeared entirely. Not one of the animals had an abscess as a consequence of the inoculation. On the sixth day after the inoculation, four animals fell sick with symptoms of rinderpest. Of these, three succumbed, and one which had the disease in a less virulent form, recovered."

"Taking into account the time of incubation, it appears very probable that these animals were infected before the inoculation, even on the very day of the inoculation the animals might have been infected, because for the purpose of injection they were thrown on the floor of a Kraal in which those cattle suffering from rinderpest were kept every night. The floor of the Kraal was covered with rinderpest matter, and being moist, it was impossible to avoid soiling them where they were thrown." . . .

"The total result for this group is—even if I consider the latter doubtful case of rinderpest—that out of 29 animals, in spite of the extraordinarily unfavourable circumstances, 25 were preserved by a single injection. To convince myself, however, beyond a doubt that the animals were actually made absolutely immune, I took on the

15th February four animals indiscriminately out of this group and injected them with virulent rinderpest blood. The injection had not the slightest effect upon the animals, whereas two other cattle which were kept segregated in the experimental station fell sick and died with severe symptoms of rinderpest, after having received an injection of the same virus."

"The results I obtained in this way with the bile injection appear satisfactory. It proves, moreover, at the same time, that the bile injection has the same beneficial effect at rinderpest farms, where infection is a matter of natural consequence, as at experimental stations where the immunised animals may be re-tested by artificial injection with rinderpest blood."

36. I have no doubt personally that Professor Koch's system of protection, by the use of Rinderpest Bile, as worked out by him in South Africa, really possesses the virtues he ascribes to it under certain conditions in that country, where the disease is of such a virulent character. But even the above experiments have not been entirely without disaster, for, some cattle injected with bile have shown an enormous mortality, and it is reported that no clean herd has yet been inoculated with bile in which rinderpest did not follow. What the outcome will be in this country cannot at present be foretold, as investigation will have to be undertaken with a view to determine many points now obscure, with regard to the different degrees of virulence found in rinderpest outbreaks.

37. There are, however, outbreaks of exceptional virulence in the Himálayas, and much less frequently such occur on the plains of India, more especially during the cold weather. With bile collected from such epidemics in the future, we may be able to obtain similar results to those which were demonstrated in the African outbreaks. But it must be clearly understood that cattle herded together at the commencement of an outbreak, cannot all be protected, even if injected with rinderpest bile, immediately the first case of disease is discovered amongst them, for, a varying percentage of animals must inevitably have contracted the disease previous to the use of the protective agent.

38. The experiments commenced at Muktesar, under the supervision of Professor Koch to ascertain the value of rinderpest bile as a protective agent against that disease in India, have up to the present proved very little, as the method has not been practically tested owing to the gradual diminution in virulence of the rinderpest blood used. Before the animals, which have been injected with the protective agent, can be proved and declared immune, it will be necessary to again procure blood from animals suffering from rinderpest in a virulent form, and subject them to inoculation with it.

39. On several occasions I have pointed out to Government the extreme importance of pursuing my investigations with regard to rinderpest, with material obtained from the most virulent source; otherwise much time would be lost and expense incurred. The result being a protective agent only powerful enough to protect

OXEN. Professor Koch's Methods of

Dr. Sullivan's Report.

animals from a very mild form of the disease, but which would render them susceptible to attacks of virulent rinderpest when exposure occurred at a later date.

40. It is unnecessary for me to go into details with regard to the protective inoculation with serum, as this, in its present form, is somewhat unwieldy and difficult of carrying out, except in experimental form.

41. Another modification of Koch's method is one which promises much more elaborate results and which can be applied with very little extra trouble. I refer to the admixture of rinderpest blood to bile in the proportion of 1 part of the former to 9 of the latter. Researches will have to be carried out in order to test several of these side issues, for, probably we may find that *ordinary* bile, if mixed with virulent rinderpest blood, may serve the same purpose, and thus we should be able to do away with one of the great difficulties of the method, *viz.*, the requirement and attendant difficulty of obtaining large quantities of rinderpest gall. In one experiment with rinderpest bile and blood tried at this Laboratory, success has attended the attempt, but it would be premature as yet to pronounce the method a success, as during further researches some unforeseen difficulties might arise.

42. If the bile method proves a success in this country when further trials with virulent material have been made, Government would be saved great expense and would probably run very little risk in the first instance by allowing their bullocks to undergo the protective inoculation. Again, it will be a great stand-bye, if during a campaign rinderpest should make its appearance on the line of communication (as was the case during the Chitral Campaign), the protective injection of bile could be had resort to, for the whole process would not incapacitate the animals for more than two weeks. The protected ones would be unlikely to again contract the disease, and they would be worth more than double their original value.

43. I would suggest, that in view of the recognised difference in the susceptibility to rinderpest exhibited by hill cattle and those of the plains, that two distinct sets of experiments be carried on concurrently, but separately, with a view to testing the efficacy of the rinderpest bile protective method and the period during which it renders the animals immune. The former could be undertaken at the Bacteriological Laboratory, Muktesar, while the latter would have to be arranged for on the plains, for it can easily be understood that by moving either set of animals from their accustomed habitat to a colder or warmer climate, as the case may be, the results of the experiments may and probably would be materially altered or entirely vitiated.

44. Whatever experiments are now initiated must be undertaken with the greatest difficulty and uncertainty owing to the want of proper accommodation for the experimental animals. Four of the plains cattle have already succumbed to *Enteritis* owing to the altered conditions of food, temperature, etc., to which they have been sub-

fected during a recent period of rain lasting some days, when 20·43 inches fell.

45. A further report will of course be submitted when the experiments have reached a more advanced stage, and something definite has been arrived at with regard to the bile method.

46. During a long conversation I had with Professor Koch concerning rinderpest, we fully discussed the different questions of interest connected with the study of this disease. The Professor indicated the lines which, in future work, would be most likely to lead to the advancement of our knowledge and produce results which may prove of the greatest benefit to Government with regard to the preparation of a serum of high protective power against rinderpest. The serum at present in use has been shown to produce a protective effect, when injected subcutaneously into healthy cattle, in quantities of not less than 100 c. cm. at one time. But future investigations must, to be of general utility, produce one possessing a much greater immunising power, so that 10 c. cm. will be able to produce a like or greater effect on the animal than the quantity now used. For the preparation of such a blood serum Professor Koch points out that a centrifugal machine must be used—each cup capable of holding at least 500 c. cm. (½ litre)—with a velocity of 4 to 5,000 revolutions a minute. For this purpose an engine of several horse-power would be required, worked by means of steam, gas, oil, or electric power. Several of these centrifugal machines are now being used in, and within a few miles of Berlin for the manufacture of diphtheritic anti-toxin and other serums, and therefore it would be advisable, the Professor points out, to wait until an opportunity offers for thoroughly examining the machinery and becoming acquainted with its working, etc., before asking Government to obtain one for the Laboratory. However, later it will be necessary to get such a machine capable of being worked by mechanical means, for it would be impossible to obtain one capable of attaining the required velocity which could be maintained by manual labour continuously for four to five hours at a time, as would have to be done on each occasion when used.

47. Again Professor Koch remarked with regard to a probable modification of serum, "Should the necessity arise to employ serum in a preserved state, there will be no other way but to dry it in the 'vacuum apparatus,' a treatment which gave most satisfactory results with other kinds of serum." Consequently, it may also be necessary to provide the Laboratory with such a vacuum apparatus in the future.

A complete set of the charts (48 in number) recording the Temperature, etc., of the above cases was submitted with the manuscript report.

3. Veterinary-Captain Pease, Principal, Lahore Veterinary School, joined the party from the commencement, accompanying Professor Koch and Dr. Lingard to Oudh, where Rinderpest was discovered. He has entered very fully into the question, and his report is produced *in extenso* :—

REPORT of VETERINARY-CAPTAIN PEASE.

REPORT OF VETERINARY-CAPTAIN PEASE.

In accordance with your instructions, I placed myself in direct communication with Professor Lingard, and acting on his instructions, I proceeded to join the party, consisting of Professors Koch, Pfeiffer, and Lingard at Lucknow, arriving on the morning of the 29th May 1897.

2. Information having been received that there were cases of Rinderpest in the district near Lucknow, we endeavoured to find some, but without success. Telegrams had been sent to Barabanki, Partabgarh, and Fyzabad. The outbreak at Barabanki, however, had, it appeared, ceased a day or two before our arrival; we then, in consultation with the district authorities of Fyzabad, proceeded to that station with a view of visiting Akhbarpur, where the disease had been reported to be prevalent.

3. The district authorities gave us every possible assistance, and we proceeded to Akhbarpur on the 31st May 1897, where we found a Veterinary Assistant. There were no cases of the disease to be found in any of the villages round Akhbarpur, but the Veterinary Assistant informed us of some disease in the villages near Tanda, a Tehsil some 12 miles distant. Thither we proceeded on the 1st of June, and having sent the Veterinary Assistant to ascertain, with certainty, where cases could be found, we proceeded to Rajipur, a village some 6 miles from Tanda, the same evening, and there saw three cases of Rinderpest. We made one *post-mortem* examination of a bull which had recently died, and found the typical lesions of Indian rinderpest present in the pylorus cæcum, colon, and small intestine. There was, however, no mouth eruption, nor inflammation of the mouth.

4. The symptoms in the living animals found suffering from the disease were, fever, discharge from the eyes, mouth, and nose, and diarrhœa. From the observations made here on these animals, Professor Koch concluded that Indian rinderpest is identical, in its nature, with that which he saw in South Africa. Flasks of blood from the heart and about 200 c. cm. of gall were collected from the dead animal. The blood was collected for the purpose of inoculating animals at the Imperial Bacteriological Laboratory at Muktesar, in order to produce the material necessary for carrying out the demonstration of the system of protection there. The next morning other villages, 6 or 7 miles from Tanda, were visited by Professor Koch, and nasal and mouth slime and dejecta were collected for experimental purposes. On the same day, we returned to Akhbarpur and took train for Kathgodam, *en route* to the Laboratory.

5. ***Professor Koch's method of conferring immunity.***—Professor Koch's method of conferring immunity may be best given in his own words:—

6. ***Method with pure bile from Rinderpest animals.***—One is able to render immune healthy cattle with the bile of such as have succumbed to rinderpest. In this case a single hypodermic injection of 10 c. cm. is sufficient. This immunity sets in on the

tenth day at latest, and is to such a degree that even four weeks afterwards 40 c. cm. of virulent rinderpest blood could be injected without any injurious effect. I therefore conclude that the immunity produced in such a manner is an "active" one, or confers more or less permanent immunity.

7. Of the injection the local result is merely a somewhat painful swelling of the size of a man's fist, which disappears in the course of a few weeks, provided, however, that the bile is not in a state of decomposition, as is not uncommonly the case when an animal suffers from rinderpest. In such circumstances, an abscess may form at the seat of the inoculation, which, however, does not seem to be detrimental to the process of immunisation.

8. ***Other modes of proceeding with bile.***—Regarding immunisation from rinderpest, Professor Koch has undertaken many experiments for the purpose of ascertaining the best manner in which the bile may be employed, and to investigate the nature of the remarkable process by which immunisation is brought about. First, a control experiment was made with the bile of a sound animal, and the result was that such bile had no immunising effect whatever. It was also found that bile taken from a rinderpest animal, which had been killed on the third day of the disease, that is, three days after the rise of temperature, which is the first symptom of the disease, had occurred, has no immunising effect whatever, and did not protect the injected animal against the disease. Even the bile from animals, which survived the attack of rinderpest proper, but were suffering from secondary disease, and died from such causes, was found to be of very doubtful or of no protective value. It may be here remarked that typical rinderpest runs its course in 7 to 8 days at longest, and that in cases lasting longer than this period after the first rise of temperature, the true action of the rinderpest virus ceases on the seventh or eighth day, and that after this the animal is suffering from the effects of such action only. These long cases, therefore, do not produce gall suitable for protective inoculation. This is very important. For theoretical reasons, experiments by mixing larger and smaller quantities of virulent rinderpest blood with the rinderpest bile, were made, and the important result obtained thereby that the bile is able to make a considerable quantity of rinderpest blood innocuous on inoculation into healthy animals, provided that the two liquids are properly mixed. That is to say, that we may inoculate a quantity of virulent rinderpest blood into a healthy animal, a dose in fact some thousandths of which would be sufficient to produce virulent rinderpest in it, with no harmful effect, provided we properly mix it with a certain quantity of rinderpest bile. In one case, 5 c. cm. of bile mixed with 5 c. cm. of virulent rinderpest blood were injected into an animal, which became immunised by this process. It appears, moreover, that the admixture of rinderpest blood with rinderpest bile even increases the immunising qualities of the bile, *i.e.* bile taken from animals at the beginning which, as we have seen above, is not of itself endowed with any immunising power, may be transformed in this way into an effective medium, and that even the bile of sound animals might

be used by such a process for the same purpose. Experiments in connection with this hypothesis are not ended as yet, and the matter is at present not definitely decided. Should these experiments give a good result, it will then be an easy matter to prepare, at any time, large quantities of highly immunising and uniformly acting protective medium. In practice, these experiments are so far of importance that they prove that contamination of the bile used for the protective inoculation with blood need, by no means, be scrupulously avoided. The results of the above experiments are anxiously awaited as the importance of this question is extreme from a practical point of view.

9. ***Immunity produced by serum.***—The blood serum of cattle which have recovered from rinderpest, has a certain immunising effect upon healthy cattle when inoculated with it. Its protective properties, however, are not very great for 100 c. cm. of such serum are required to protect an animal against an inoculation with a small dose of rinderpest blood. This immunity is merely a "passive" one, and will only last for a short period. For protective inoculation on a large scale such serum is not applicable, but Koch succeeded in immunising in a fortnight several animals by means of a mixture of serum and virulent rinderpest blood, to such a degree that they were enabled to withstand an injection of 20 c. cm. (about 300 drops) of rinderpest blood, a ten thousandth part of which is a fatal dose. From this fact he judges that the immunity of these animals is of a much higher degree, and he believes that it is an active immunity equal to that of a beast which has contracted rinderpest and has then recovered.

10. It is particularly important to know that only 20 c. cm. of such serum are required to immunise an animal.

11. From the above experiments, Koch is led to believe that rinderpest can be eradicated with but little difficulty and within a comparatively short time by putting these methods into practice.

12. In infected parts of the country, nearly every case of rinderpest supplies a greater or lesser quantity of vaccine for those animals which are still healthy, and he is sure that thousands of cattle may be saved daily by its application.

13. Methods demonstrated at the Laboratory. The method of protection by the inoculation of cattle with simple rinderpest bile is the one which Professor Koch demonstrated to us in India; unfortunately, owing to various circumstances, he was unable to spare the time to go through all his methods, as his time was too short, only one variation was made in the inoculation, and that was the admixture of virulent rinderpest blood to the rinderpest bile. He carefully explained others to me, and Dr. Lingard will doubtless verify and continue all the experiments as opportunity occurs.

14. ***What proof necessary as to the efficacy of the method.***—The only proof which is necessary as to the efficacy or otherwise of this method is, to take a number of healthy animals susceptible to the disease and to inject each of them with 10 c. cm. of bile of suitable quality from an animal affected with rinderpest, and after keeping the animals carefully isolated for ten days (the period which

must elapse before immunity is complete) to inject a very large quantity of virulent rinderpest blood (10, 20, or even 40 c. cm.) subcutaneously into them, and at the same time to inoculate one or two other unprotected animals, as a control, with a similar dose of the virulent blood. What must then happen is, that the bile-injected animals must not contract rinderpest, whilst the non-protected or control animals must take the disease and die or at least become very ill and exhibit diagnostic symptoms of the disease. This will prove that the bile-injected animals are immune from the disease. The control animals are, of course, used to show that the rinderpest blood with which the bile-injected animals have been inoculated, is virulent and capable of producing severe fatal rinderpest in unprotected animals. Failure in any of these points then will render the test negative or doubtful. If the bile-injected animals die, it will be negative, if the control animals do not take severe rinderpest it will be doubtful.

15. ***What is necessary for the demonstration.***—In order to carry out an experiment of the immunising properties of bile, then what is necessary is first to produce virulent rinderpest in some animals; secondly, to take the bile at the proper time and in suitable condition and to inoculate subcutaneously the animals it is desired to protect with 10 c. cm. of the bile; thirdly, ten days after the inoculation with the bile, to submit the animals which have been subjected to the bile inoculation to a test inoculation with a very large dose of the virulent material; fourthly, to inoculate at the same time, and with a similar dose of the same virulent material, a couple of susceptible and unprotected animals to act as a control to the experiment; and fifthly, to observe that in the bile injected animals no rinderpest occurs, whilst in the non-protected controls rinderpest with its diagnostic symptoms occurs.

16. ***Method of infecting healthy animals with virulent disease.***—It is obvious that in carrying out these experiments, it is first very necessary to have some certain standard method of producing the virulent disease amongst healthy animals in order to provide the material required for protective inoculation, as well as virulent virus with which to test animals. The method which has been in vogue in Russia, for a very long time, is feeding with virulent dejecta and smearing the nostrils with slime from animals suffering from the disease. Professor Koch states that he has been able to demonstrate that the ordinary methods of infection hitherto employed are exceedingly ineffective, and that a large proportion of those cattle that it was tried to infect by means of slime from diseased animals smeared on the mucous membrane, etc., failed to contract the disease.

17. The method of infection, which he advocates, is the injection of defibrinated blood into the dewlap, and in this manner a very severe form of the disease, which has an incubation period of three to five days, is produced, the animals succumbing and exhibiting all the *post-mortem* appearances of rinderpest. By this method every experiment has been positive in South Africa.

18. ***Best time for taking the blood for incubation.***—The blood for this purpose is best taken at an early stage of the disease,

when the blood of the affected animal will generally be free from putrefactive or other germs and contain only the virus of rinderpest. It may well be taken on the third or fourth day after the first rise of temperature. The virulence becomes less at the end of the disease, as has long been known.

19. ***Method of collecting blood from the living animals.***—In order to collect virulent blood from the living animal, it is necessary to cast and secure the beast in the ordinary way. A round block of wood is placed under the neck in a suitable position to raise it at the part where the operation is to be performed. The spot selected over the jugular vein is determined by bending back the ear and noting where the tip rests. The hair is now closely cut or shaved over the seat where the incision is to be made and the part carefully cleansed with perchloride solution. The vein being now raised, an incision two or three inches long is made with a sterilised knife through the skin on to the jugular vein, freely exposing it. A sterilised trocar and canula is now pushed into the jugular, and the trocar being removed, the blood is allowed to flow into sterilised vessels. The wound is now carefully sutured, and the animal after the application of antiseptic to the part is allowed to rise.

20. ***Blood should be defibrinated.***—The blood is now defibrinated either by beating it slowly with a clean wire whisk, or by shaking for a considerable time in test tubes or flasks. It is necessary to remember not to whirl the whisk round, but to beat the blood gently with it. The defibrinated blood is now ready for use. But previous to use, it should be strained. If the blood has been collected aseptically into sterile vessels and is kept in ice or very cool, it will remain unchanged for a long time, but if not, it will, of course, putrefy owing to contamination with putrefaction germs.

21. ***Method of using the blood for inoculation.***—The strained defibrinated blood is now poured into a sterilised syringe, and is injected subcutaneously into dewlap.

22. ***Quantity of blood used.***—The quantity of virulent rinderpest blood which has been found capable of producing virulent rinderpest in South Africa is $\frac{1}{1,000}$th of a c. cm., a very minute quantity. But in practice, in order to make certain of producing the disease, a very large dose, *viz.*, 10 c. cm. or about 150 drops, is injected.

23. ***Local effect of the inoculation.***—The local effect of the subcutaneous inoculation of rinderpest blood, taken in this way, is only the production of a small swelling which rapidly disappears, causing little trouble as a rule. If the blood be contaminated with putrefactive germs, an abscess may of course form, or other serious consequences result.

24. ***Method of collecting bile for immunising cattle.***—The method of collecting bile from an animal dead of the disease, is as follows:—The animal lying on the left side, an incision is made on the right side, transversely to the long axis of the body completely round the posterior edge of the last rib. The flank is then cut

back, care being taken to avoid wounding the intestines. The ribs are then lifted up by an assistant, pulling them upwards and forwards, and the gall bladder is found lying immediately beneath. A clean sterilised flask being ready, the gall bladder is grasped at its base by an assistant, in such a manner as to render it quite tense, and a small nick is now made into the most convenient part with a clean scalpel and the bile allowed to flow into the flask.

25. ***Amount of bile yield in Rinderpest.***—The amount of bile yield from animals dead of rinderpest necessarily varies considerably according to the size of the animal. Some small animals only yield about 100 c. cm., larger ones 200 c. cm., and Professor Koch informs me that the large South African oxen sometimes gave as much as a litre (1¾ pints). The quantity is invariably larger than in health, the fulness of the gall bladder being a prominent symptom *post-mortem* of the disease.

26. ***Period of the disease when gall is most suitable.***—This is an important point, as it has been proved that at certain periods of the disease the gall possesses no immunising properties. It has already been proved by experiment, for instance, that gall taken on the third day after the rise of temperature is endowed of itself with no immunising properties. It has also been proved that gall taken from animals which have exceeded the period of pure rinderpest is valueless or of doubtful value. The bile is best suited for immunisation and possesses its most powerful action on the seventh or eighth day of the disease.

27. ***Character of suitable bile.***—It has already been stated that the bile from all animals dead of rinderpest is not suitable for the purpose of conferring immunity against the disease, and it is important to be able to recognise bile which is fit for use. Bile collected on the seventh or eighth day which is of green colour, almost clear, free from offensive smell, giving off that of healthy bile only, and free from harmful bacteria is in a suitable condition. When it contains harmful bacteria, its physical and chemical properties are changed, and its smell differs from that of good bile, whilst its colour becomes yellowish or brownish.

28. ***Length of time which bile retains its properties.***—This important point has not, so far, been definitely settled, but it is known that in ordinary conditions it soon decomposes. If it be desired to keep it for any time, it must be carefully collected aseptically and kept cool in ice. How long, however, in these circumstances it retains its immunising properties is unknown.

29. ***Method of making the injection.***—The gall should be used as fresh as possible. The vessel containing it should be shaken, and then 10 c. cm. of it poured out into a clean syringe (Kooh's pattern is most convenient) capable of containing that amount. The animal to be operated upon having been properly cast and secured, the needle is introduced into the subcutaneous connective tissue under and to the side of the sternum, and the material injected and worked into the tissue a little by rubbing with the fingers. Care is necessary to see that the point of the needle lies free in the subcutaneous tissue,

and is not sticking into the skin or the muscular tissue lying beneath. Koch usually injected some air with the bile.

30. *Local effect of the injection.*—The effect of the local injection of the bile is the production of a considerable amount of swelling and inflammation, pain and tenderness. The swelling varies in size, but should not be less than that of a man's doubled fist. Koch lays some stress on the necessity for considerable swelling, and the seat of the injection has been purposely chosen to ensure this. The result of the injection, then, is sometimes lameness for a few days, owing to the seat of the inflammation which is produced. The swelling remains painful for a few days after which it gradually disappears going down in the second week.

31. *General symptoms produced by the injection.*—If the bile is of suitable quality and uncontaminated with putrefactive organisms, there is no general symptom produced by the injection of the bile, the temperature remaining normal and the animal apparently in its usual health and spirits.

32. *The action of bile in producing immunity.*—The manner in which the bile produces immunity is not certainly known, but its action is believed due to the irritation which it causes on inoculation. It has been above remarked that the bile in the earlier stages of the disease is incapable of conferring immunity, as is also the fact that, that from old cases has no action. It must be taken at the "acme" of the disease, when the whole system is saturated with the poison. The bile at this time is supposed to contain the greatest quantity of the most virulent virus of rinderpest, when we inoculate this bile containing the virus, as we have already seen a considerable amount of local inflammation is immediately set up and considerable inflammatory effusion takes place into the part. This prevents any absorption of the virus by the lymphatics from the seat of inoculation. The virus soon perishes at the seat of inoculation or undergoes certain changes there, and the products of its metabolism are mixed with the exuded material. This mixture is now gradually absorbed, and confers immunity in the same manner as do the anti-toxins of other diseases. This method of action is rendered the more possible for the reason that it has been experimentally proved that it is possible to mix large quantities of virulent rinderpest blood with the bile, and that the inoculation of cattle with this mixture confers immunity.

33. *Quantity of Rinderpest bile required to produce immunity.*—To ascertain what doses of rinderpest bile are required to produce immunity, Koch injected three cattle with 1, 2, and 5 c. cm. of bile each, and gave ten days later 0·2 c. cm. of rinderpest blood by subcutaneous inoculation, all these animals fell sick subsequently with severe symptoms of rinderpest, the one inoculated with 5 c. cm. recovered, and the other two died. It may, therefore, be safely concluded that an injection with less than 10 c. cm. of bile is insufficient to render cattle immune against rinderpest.

34. *Time required to produce immunity with bile.*—It must be borne in mind, that the bile does not surely produce its

immunising effect until ten days have elapsed since its injection. There is, as it were, a period of ten days' incubation of the immunity, during which, if the animal be exposed to the contagium of rinderpest, he may take the disease as easily as an animal which has not been protected. It must, therefore, be remembered that rinderpest bile does not produce immunity until these full ten days have elapsed after which only is the proof against the disorder. This is a most important point. It must not, therefore, be concluded in any set of experiments that, if there has been any possibility of mediate or immediate contagion during this incubative period, the method of immunisation is not an efficient one. What would be necessary to disprove the efficacy of the system would be, the infecting of animals after the proper period has elapsed since the immunising inoculation with suitable gall was made. Animals which have been exposed to the contagion before the protective inoculation is made, or which have been so soon afterwards, therefore may contract the disease. This exposure to contagion must naturally occur in the case of outbreaks in India, where, owing to lateness in reporting outbreaks, to communal grazing, and to general carelessness a great number of animals in a village will always have been exposed to the disease by feeding and drinking, as well as by actual and mediate contact with diseased animals. In any attempt, therefore, to adopt the system in a village, we must necessarily inoculate a number of animals which have already the virus of the disease in their system, or which may take it in during the ten days which must elapse before immunity occurs. This is the more probable when we consider that an animal does not show any symptom of rinderpest at all until from three to five days have elapsed after taking in the poison, and the only symptom then shown is rise of temperature for 48 hours or so. Such animals would, of course, have an attack of the disease in the ordinary course.

35. ***Professor Koch's experiments at the Imperial Bacteriological Laboratory.***—We left Tanda on the 2nd June 1897, and proceeded as rapidly as possible to the Muktesar Laboratory, where we arrived on the evening of the 4th June. The virulent material, blood slime, fæces, etc., had been carefully packed in ice on the journey, and most of it arrived in good condition. Most of the blood brought up was considered to be fit for use, the only danger being that cold might have destroyed the virus. No bacteria were found in the blood on microscopical examination. In the evening of the 4th June, two bullocks, numbered I and II, received subcutaneously 10 c. cm. each of the defibrinated rinderpest blood collected at Tanda, previously strained. The inoculations were made with sterilised syringes into the subcutaneous tissue under the sternum, the animals being cast and secured for this purpose. The temperature charts of these animals marked 1 and 2 will show the course of the disease in them. In bull I the rise of temperature, which is the first symptom of rinderpest, occurred on the 7th June, and the usual symptoms of virulent rinderpest, *viz.*, discharge from eyes, nose, and mouth, dulness, loss of appetite, staring coat, abdominal pain, diarrhœa, and dysentery, followed in their usual

course, the animal succumbing on the morning of the 14th, or on the seventh day of the disease. The temperature curve of this animal is a typical one of severe rinderpest and closely corresponds with those shown to me by Professor Koch and taken in South Africa. The *post-mortem* examination, conducted by Professor Koch himself, was one of typical Indian rinderpest, and confirmed his opinion that the disease here is identical in its nature with that which he met with in South Africa.

36. The temperature chart of No. II is also sent for perusal. This shows a typical rinderpest curve, the disease not so virulent in its nature. All the symptoms detailed in No. I were present, but the animal would probably have recovered had it been possible to feed him properly, as *post-mortem* examination showed that the lesions were healing. These two inoculations were made to produce bile in a proper condition for the inoculation of other animals with a view to conferring immunity. It will be seen, therefore, that No. I would be suitable, whilst No. II would not be. The bile taken from No. I was considered by Koch to be in a very good condition, and was utilised for the immunising inoculation of Nos. XIII, XIV, XVI, XVII, and XVIII.

EXPERIMENTS—GROUP II.

Production of Rinderpest.

37. Another experiment which was made was, with a view to testing the slime and dejecta which had been collected at Tanda, as to their virulence, and for this purpose the animals Nos. III and IV plain's cows, were selected. On the 6th of June, No. III received about 10 c. cm. of the blood-stained dejecta as a drench mixed with water, and had the nostrils smeared with slime taken from a buffalo suffering from severe rinderpest. The temperature chart, sent herewith, marked 3, shows that on the 11th June, or five days after receiving the material, she was attacked by virulent rinderpest, all the symptoms of which followed, and that death occurred on the 18th or seven days after the rise of temperature.

38. No. IV, on the other hand, which received on the same day similar material taken from a bullock at Tanda had what appeared to be only a very slight attack lasting for five days, or from the 16th June to the 21st. The symptoms, however, were not well marked, and it is somewhat doubtful whether the animal really suffered from rinderpest or not, although it is believed that she did owing to the unfortunate fact that our rinderpest virus has almost completely lost its virulence; we have been unable to subject this animal to a test inoculation with virulent rinderpest blood.

EXPERIMENTS—GROUP III.

39. *Immunisation.*—Of the bile collected at Tanda, two animals, the only ones available for the purpose and numbered V and VI, received subcutaneously into the breast 10 c. cm. These animals were under my

Tanda bile, 5 days old.

charge. The injection was followed by the usual swelling at the seat of inoculation and the animals continued otherwise in good health.

40. ***Test of efficacy of the bile injection.***—On the eighth day following the injection, Dr. Koch having been ordered by the Imperial German Government on special duty had to leave. He decided to apply the test to these animals himself before leaving. This was done by taking the blood of No. I bull dead of virulent rinderpest and injecting 10 c. cm subcutaneously; young buffalo No. XV. unprotected received a similar dose to act as a control to the test.

Results.—The tested animals were placed in the rinderpest shed on the same day that they received the test injection of virulent blood. The result of the test was that on the 19th, or five days after the inoculation, cow No. V became sick and passed through all the phases of a mild attack of rinderpest, lasting five days, after which she recovered and is now in good health. No. VI showed no symptoms of the disease at all, continuing in good health, until the expiration of 3 weeks, so that he appeared to be immune.

41. The control animal No. XV, however, only had a very slight and short attack of the disease from which he was at no time very ill, although he had not been protected in any way, and although he received a large dose 10 c. cm. of the virulent material, he recovered.

42. ***Doubtful benefit.***—It appears, therefore, from this experiment that cow No. V had no immunity conferred by the bile, or at least only a very slight amount, and at the same time that the rinderpest virus is losing its virulence.

EXPERIMENTS—GROUP III.

43. ***Immunisation.***—In the meantime, more animals having become available, four animals Nos. VII, VIII, IX, and X received 10 c. cm. of the original Tanda bile by subcutaneous inoculations in the usual manner. The bile had not apparently changed in its properties, and contained no more bacteria than before. These animals were inoculated with the bile on the 10th June, or when the bile was 10 days old. They remained in good health after the inoculation, and it was decided to test them with virulent material on the 21st of June.

Tanda bile, 10 days old.

44. ***Test of the experiment.***—Blood was taken for this purpose from the jugular vein of case No. XI which had been infected with rinderpest from bull I for this purpose. The blood was taken from the living subject in the usual manner on the seventh day of the disease which had been severe in him up to this time. A little variation was made in the manner of testing in this case inasmuch as VII and VIII received each 10 c. cm. of virulent blood, whilst IX and X received only 0·2 c. cm. of the blood mixed with physiological salt solution.

45. ***Control of the experiment.***—At the same time, a small bull No. XIX unprotected, received an inoculation of 10 c. cm. of the same blood to act as a control to the experiment.

46. *Result of the experiment.*—This experiment is a most unsatisfactory one, but at the same time interesting and important. The four cows which had received the bile injection were placed in the rinderpest shed. Nos. VII, VIII, and X remained perfectly healthy. No. IX, on the 27th June or the sixth day following the inoculation, commenced an attack of rinderpest which proved somewhat severe, but was not very dangerous, lasting six days and being followed by perfect recovery.

47. At the same time, the control animal XIX remained healthy in appearance and had no rinderpest.

48. *What the experiment proves.*—It will be seen, therefore, in this experiment, that Nos. VII, VIII, and XIX which received 10 c. cm. of blood, remained healthy, as did also No. X which received only 0·2 c. cm., whereas No. IX which had only received 0·2 c. cm., became attacked by the disease. It is quite possible that this animal was injected from cow V which was suffering from rinderpest, the attack being at its height when these animals were introduced into the rinderpest shed. They stood in the following order:—

VII	VIII	X	IX	V	VI	XII	XIX	IV	XI	XII	XV

This experiment, therefore, proves little with regard to the power of the bile used of conferring immunity, as at least one of the animals operated on, contracted the disease, after the time necessary for immunisation had passed.

49. It also proves very clearly that the virulent blood used for the purpose of testing the immunity conferred by the bile, had so far lost its power of producing the virulent disease when injected into an unprotected animal, for, as we have seen, our control animal although it received a very large dose of the blood taken from No. XI suffering from rinderpest, and although it was entirely unprotected, still it did not take rinderpest.

50. This also renders it probable that Nos. VII, VIII, and X have also not received any immunity from the bile injection.

51. Unfortunately, these animals cannot at present be re-tested owing to our having no virulent blood.

52. *The above experiments no proofs either way.*—The above experiments with the view of testing the immunising power of rinderpest bile are merely experimental, and cannot be taken as proving anything against Koch's method, because, in the first place, the bile was taken from an animal which, it is said, had been dead for some time, and which had been suffering from rinderpest and its effects for over ten days, and it has been kept for five days in ice, whilst, at the same time, it was yellowish and contained some bacteria. In addition to this, the test inoculation was made too soon

in the case of the first animals V and VI, viz., on the eighth day after bile inoculation, instead of the ten days laid down by Professor Kooh.

53. ***Further experiments with Laboratory animals. Group V.—Rinderpest.***—So much then for the experiments regarding attempted immunisation with the bile brought from Tanda, experiments upon which, as has just been remarked, no reliance can be placed, as regards the evidence they might be considered to give regarding the efficacy or otherwise of Professor Kooh's method.

54. With a view to continuing the supply of virulent material for testing purposes, Nos. XI and XII were inoculated with 10 c. cm. each of virulent rinderpest blood taken from the jugular vein of No. I on the 11th June when the disease was at its height. Both these animals went through a severe attack of the disease, with all the typical symptoms, but both of them recovered and are now in good health. This further points to loss of virulence in the rinderpest blood.

EXPERIMENTS—GROUP VI.

55. ***Immunisation.***—With the bile collected from bull No. I dead of rinderpest on the 14th June on the seventh day of the disease five other animals, Nos. XIII, XIV were inoculated by Professor Kooh himself on the 14th June 1897, and XVI, XVII, and XVIII by Professor Lingard on the 15th June 1897.

56. ***Blood and Bile.***—The inoculation was varied in the case of No. XIII which received a dose of 9 c. cm. of rinderpest bile mixed with 1 c. cm. of virulent blood, as it is supposed that by this means the immunity conferred is more powerful and lasting. All these animals have been under observation since the inoculation, and have remained perfectly healthy.

57. It is a noteworthy fact that the injection of 1 c. cm. of rinderpest blood did not cause the disease in cow No. XIII, and this goes to prove that Professor Kooh's observations on this point are correct, and leads us to hope for a simple method of procedure in the immunisation process.

58. ***These cases not tested.***—It is an unfortunate circumstance that our rinderpest blood has so greatly lost its virulence as to be useless for test purposes, which necessitates the use of the most virulent material, in order to prevent errors, we have, therefore, been so far unable to submit the animals mentioned in the above group of experiment to the necessary test.

59. ***Impossibility of giving a definite opinion on the method.***—In the above-mentioned groups of experiments, it will be seen that no definite proofs of the efficacy or otherwise of the method has been adduced. It is impossible, therefore, for me to give an opinion on this point. I have, however, not the slightest doubt in my own mind that the method is genuine in regard to South African cattle, judging from the experiments which Professor Kooh showed me, but, whether the method will be successful in Indian cattle or not remains to be seen.

60. *Differences in Indian and South African Rinderpest.*—Professor Koch has only dealt with the disease as it occurs in South Africa, which assumes a very virulent form, carrying off a very high percentage of the animals which it attacks (90-98 per cent.) and running its course rapidly and with great severity. It has long been known to those who take any interest in the subject, that certain contagious diseases, notably small-pox, measles, etc., when introduced into a country for the first time, the contagium having, as it were, a virgin soil to grow upon, assume a very exalted virulence, causing excessive mortality. The same is especially true of Rinderpest as may be remembered by those who were unfortunate enough to be connected with agricultural pursuits during the great outbreak in England.

61. In India, however, as in certain parts of Russia, where the disease is enzootic, the disease varies very considerably in its course and severity. We very often meet with rinderpest in what has been termed the "Benignant form." It may, indeed, be so slight as to pass unnoticed there being no symptoms but slight fever and looseness of the bowels. We have in fact similar conditions as are met with in the Steppe Cattle, which, as is well known to those who have given attention to the subject, perish from natural contagion at the rate of 30-50 per cent. and from inoculation with the natural unweakened virus in from 5-10 per cent. only.

62. *Rinderpest here resembling Steppe Disease.*—The disease which we introduced to the Laboratory for the purpose of making experiments appears to me to closely correspond with Steppe disease.

63. The material was from an outbreak of not a very virulent nature, the disease having been dragging on in the neighbourhood for some very considerable time. It was taken from a dead animal in a village where the disease was evidently losing its virulence, as was apparent from the fact of the slowness of the spread and the length of time the cases were lasting. On inoculation at the Bacteriological Laboratory two bulls I and II, we find that in No. I it produces a typical case of virulent rinderpest destroying the animal in a typical period. No. II lasted over the period of rinderpest (seven days), and would probably have recovered had it been possible to feed him properly. Blood taken from the vein of bull No. I on the 11th June, when the disease was at its height, and all the typical symptoms of rinderpest present, and the temperature high (at the most suitable period in fact), and injected into Nos. XI and XII produced typical rinderpest as will be seen from the charts of these animals sent herewith, but the disease was evidently of a far less virulent nature, as both these animals recovered and regained their usual health, after a smart attack of the disease lasting from five to seven days respectively.

64. Blood taken from No. I *post-mortem*, and inoculated as a test to Nos. V and VI previously inoculated with bile from Tanda, produced in the cow an obvious though comparatively slight attack of rinderpest from which she recovered in a few

days. In VI the injection produced no effect at all, the animal remaining perfectly healthy. In the control animals, we find that although the animal is unprotected (see No. XV) the injection of blood from No. I produces, after seven days, very slight rinderpest, lasting practically only two days, as far as symptoms show, and from which the animal recovered.

65. Further, we find that the blood from No. XI, taken on the 21st June, on the seventh day of the disease, and inoculated into No. XIX to act as a control animal to Nos. VII, VIII, IX, and X did not produce the disease in this animal.

66. Again, blood taken from the buffalo No. XV and inoculated into XXII produced only a mild attack of the malady which showed none of the typical symptoms of rinderpest. Thus we have a decreasing scale of virulence in the material as follows:—

Tanda Blood

No. I — typical death. — No. II — typical death.

XI — Mild typical recovery. — XII — Mild typical recovery. — XV — Mild typical recovery. — V — Mild typical recovery. — VI — Mild typical recovery. — *Nil*

XIX — *Nil* or Control slight recovery. — XXII — Mild, a typical recovery.

None of these animals, excepting V and VI, had received any form of immunising injection.

67. Here, then, we have a state of affairs closely resembling what is described by E. Semmur as occurring in Steppe cattle, and the task of ascertaining what the significance of this may be must be left to future experiments *suggested explanations of the phenomenon*. It certainly appears to me that there are only two solutions of the phenomenon of the decrease in virulence of the rinderpest virus brought with us from Tanda, and these are, *first*, that some Indian cattle, especially those of certain plain districts, possess a similar immunity against rinderpest to that possessed by Steppe cattle, or *secondly*, that the virus of the disease has a tendency to lose its virulence in certain circumstances, the exact nature of which we are unable to decide. If the first solution should prove correct as seems probable, we can easily explain the decrease observed here. If the second, the explanation can only be unsatisfactory. It is known to some of us that the immunity which Steppe cattle possess is not shared by other breeds in Russia, and that, whereas the inoculation of natural unweakened rinderpest virus in them is followed by only 5-10 per cent. of casualties, the same inoculation in other breeds of cattle causes 90-98 per cent. of deaths.

68. It is also known to us that the virulence can be considerably lessened by passing the virus through Steppe cattle, whilst we are also aware of the fact that when such attenuated virus is passed

through other races more susceptible, the virulence increases generation by generation.

69. *Indian Rinderpest.*—My own observations and those of Thacker and others are to the effect that we meet with many outbreaks where the mortality is not greater than 30-50 per cent. But, on the other hand, we often hear of severe outbreaks in which it is 80-90 per cent. This can only be explained either by the comparative immunity of certain cattle to the disease, as is the case with Steppe cattle, or to some decrease in the virulence of the virus owing to some influence exerted on it from outside, such as partial desiccation or exposure to a high temperature.

70. *Influence of heat and dryness.*—I have, judging from my own practical experience of the disease, extending over many thousands of cases, been led to the conclusion that the heat and dryness were the causes of the lack of virulence in the disease as met with in the plains as opposed to the great virulence and severity of the disease observed in the parts of the Himálayas. The observations I made showed, plains 30-50 per cent. deaths, parts of the Himálayas 90-98 per cent. deaths. We are well aware from experiments already made that a vaccine can be prepared by exposure of the virulent material to a temperature of 117·0 F. to 120·0 F. for 10 minutes. This exposure so reduces the virulence that the material can be inoculated and produce immunity without causing severe disease. These temperatures are not unfrequently met with in India in the sun, and the influence of this on the virus would, it appeared to me, sufficiently explain the low mortality in some outbreaks.

71. In some parts of the Himálayas on the contrary, where the temperature is cool, and the air moist, the disease is very severe.

72. *Indian bile less protective than the South African.*—These various points can only be settled by close observation and experiments. But there is one very important point which may arise in connection with this slight virulence. It is very possible that the bile from an animal dead of such a virulent form of the disease as has been occurring in South Africa especially in view of the experiments made by Professor Koch in regard to mixing virulent blood with the bile to increase its immunising power, may be endowed with far higher powers of conferring immunity. From theoretical reasons this seems to me not improbable. The bile appears to owe its protective power to the rinderpest virus it contains, and Koch's experiments of adding blood increase such power. It stands to reason therefore that if this be the case, the milder the virus, the less will be the immunising power than that from severe rinderpest, and we shall have, in India, to deal with an entirely new aspect of the subject.

73. *Prospects of the practical application of the method in India.*—In regard to the applicability of the method in its present form to this country, it may be said that perhaps it is at present too early to give an opinion. It may, however, be said that it is in its present form rather unwieldy and would only be applicable to certain cases in which it might be extremely useful should it prove to be efficacious.

74. Professor Koch's experiments in the practical application of the Immunisation process at the "Summa" farm, show that it will do a considerable amount of good. He reports as follows:—Rinderpest broke out there on the 20th January 1897, I visited the farm on the 2nd February, and found the stock of 180 head already much infected. Twenty-seven animals were dead, and at least 50 showed more or less clear symptoms of rinderpest. Experiments in protective inoculation with the animals which still appeared sound were undertaken, and 18 diseased animals were injected with blood a proportion of phenol and lesser proportion of bile. Ten animals which appeared sound received the same phenol blood, and 29 cattle which also appeared sound and had been kept seperate were injected with bile which was taken from an animal which has died after an illness of six days. On the sixth day after the inoculation, four animals fell sick with symptom of rinderpest, of these three succumbed, and one which had the disease in a less virulent form, recovered. There was every possibility of these animals having been infected before the inoculation, for which they were thrown on the floor of a "Kraal" in which cattle suffering from rinderpest were kept every night, and this floor was covered with rinderpest matter. Out of 29 animals, in spite of the extraordinarily unfavourable circumstances, 25 were preserved by a single injection. To prove beyond a doubt that the animals so treated were absolutely immune, Koch inoculated four of them with virulent blood, and, at the same time, two unprotected ones to act as control. The four remained well, whilst the controls died with severe symptoms of rinderpest. From the above, it will be seen that the system may be adopted with advantage even in unpromising circumstances.

75. ***Inoculation of Transport animals on service.***—It seems highly probable that the method might be very useful in the event of outbreaks of rinderpest on the lines of communication. It would have the result at any rate of stopping an outbreak in a fortnight, and the inoculated animals would be proof against the disease afterwards.

76. ***Inoculation of Transport animals before service.***—It would be very useful to inoculate animals intended for service in parts of the country where rinderpest is prevalent. The advantage of having protected animals on these expeditions would be enormous, as they would be able to march unscathed through a country however severely infected it might be.

77. ***Inoculation of all Government cattle.***—This might in the course of time be gradually carried out; I would especially draw attention to the advantages following the protection of Government breeding bulls previous to sending them out to their districts.

78. ***Inoculation during outbreaks amongst Transport cattle.***—In the case of outbreaks among transport cattle in Cantonments, the system, should it prove successful, might with great advantage be adopted. There would be material at hand from the animals already attacked, and many animals might in these circumstances be saved and protected against the disease in the future.

79. ***Inoculation during outbreaks in the districts.***—But in the case of outbreaks in the districts, it could not well, it seems to me, be utilised to any extent at present. It must, in the first place, be remembered that the immunising process takes a considerable time, nearly or rather quite ten days, and that before this time has elapsed, should the animal be exposed to the contagion, it will take the disease.

80. In outbreaks of rinderpest, therefore, in this country, where communal grazing and herding occurs, it is always doubtful whether many animals will escape exposure to the disease during an outbreak, owing to the lack of segregation, and great carelessness which prevails in the management of matters of this kind; what is likely to occur in nearly all outbreaks may be well illustrated by the following case which is reported in the *Diamond Fields Advertiser*. The disease appeared in a herd of 248 cattle, of which only one or two were observed to be sick. These were instantly removed from the herd and isolated, while the rest were inoculated. This was done on the 27th February. On the 12th March, no less than 40 had taken the disease, but the remainder were apparently doing well. Now we are pretty certain, judging from all the experiments which have been made with rinderpest bile, even when it is mixed with a considerable quantity of virulent rinderpest blood, that its inoculation into healthy cattle does not cause rinderpest. The small experience which we have so far had in this country proves this. How then are we to account for the 40 head being attacked? Simply because during the incubation period of the immunity or before the inoculation period they had been exposed to the disease and become infected. But I am afraid that it might be difficult to get the people of this country to see the matter in this light at present.

81. ***Protection of healthy cattle most hopeful.***—It has already been stated in the South African enquiry that the best results are to be obtained in operating on healthy cattle. If any method of inoculation against rinderpest is to become spread over the country, it can only safely be done by feeling our ground carefully and introducing it very gradually, commencing by inoculating at various centres animals with a view to rendering them immune and also by operating to some extent on Government animals. It might be very useful to inoculate a portion of the cattle distributed as "Thakavi grant" in villages where rinderpest has been very severe, and there is danger of recrudescence owing to which the animals bought with the "Thakavi loans" perish, and the unfortunate *raiyat* finds himself worse off than before.

82. ***Drawbacks of the present system.***—The present system has serious drawbacks owing to which its application to the protection of healthy animals is limited. In the first place, it is necessary to have the disease carrying off animals, to supply the material, and each animal supplies only a limited quantity of the protected bile. Secondly, all the dead animals do not supply bile fit for use. The supply of bile, therefore, can only be kept up by the inoculation of animals, which would be a rather costly process; and thirdly, it appears that the bile will not keep good, retaining its properties

REPORT OF VETERINARY-CAPTAIN PEASE.

for long. These are all serious questions which must be left to the proper authorities to settle.

83. *Koch's other methods more hopeful for practical application in India.*—The further experiments in regard to the use of bile from healthy animals and its admixture with virulent blood, or the possibility of using other material with which the virulent blood may be mixed and at the same time produce immunity, seem to render it very probable that the means of manufacturing a more or less artificial protective medium seem to me to promise the best results in the matter of providing large quantities of vaccine, and it is to the solution of these problems that I look forward with most hope.

84. *Possibility of teaching Veterinary Assistants the system.*—The system if it be on the lines of any laid out by Professor Koch can be easily taught to some of the more intelligent of the students with a properly equipped contagious disease hospital in Lahore, in working order; the whole of the practical technique and theory of the subject, which is fairly simple, can be thoroughly taught, if the Government decided to extend the course to three years.

85. *An important practical point definitely settled.*—I may mention that Professor Koch has confirmed the observations of Semmur and others in regard to the efficacy of drying in the destruction of the rinderpest virus. He states, "In continuation of my experiments with dried rinderpest matter, several animals were fed with the dung, flesh, and skin of the pest animals, which substances were dried for a fortnight in the shade and soaked before feeding. The animals remained perfectly sound." In accordance with these facts, the conclusion may be justified that the pest virus in its different qualities, is soon killed by dryness, and that the dry process forms one of the simplest and best ways to render rinderpest matter innocuous.

86. This has a most important bearing on the hide trade. I pointed out so long ago as 1894, that drying destroyed the rinderpest virus and that dried hides do not form a danger in the transmission of rinderpest.

87. This fact will also again bring into prominence my recommendation for the establishment of skinning enclosures outside every village, in which the *Chamárs* should be made to skin dead cattle, as a part of the village arrangements. This will limit the spread of rinderpest in a very marked manner. If the animals be skinned, as suggested in my Annual Report of last year, the sun will soon destroy the rinderpest virus. The skins should be dried in the enclosure and on no account washed in the village tank. The adoption of simple methods of this kind will go a long way to help the people and are really of very little trouble.

88. In conclusion, I have to thank Professor Lingard for his courtesy and assistance during my deputation, and for giving me opportunities of studying in the Laboratory, during my vacation.

4. Veterinary-Captain Hagger, Principal, Rajputana Veterinary School, reports as follows:—

VETERINARY-CAPTAIN HAGGER'S REPORT.

VETERINARY-CAPTAIN HAGGER'S REPORT.

With reference to your endorsement No. 3841-G—869, dated 28th August 1897, I have the honour to submit the following remarks on Dr. Kooh's method of inoculating cattle as a preventive against rinderpest, as witnessed by me at Muktesar in June last.

2. Dr. Kooh claims to have proved that ten cubic centimetres of bile, taken from the gall bladder of a bullock that has died of rinderpest on the sixth day of the disease, will, when injected into a healthy animal, render that animal immune to the disease after the sixth day.

3. He distinctly points out that it is not a curative agent, and admits that cattle exposed to infection either just before, or within six days after the operation, are liable to suffer from the disease, but he states that those attacked after they have been inoculated, and before immunity has been given, *i.e.*, before the sixth day, suffer less in proportion to the number of days that have elapsed after the immunising agent, *viz.*, bile, has been injected, and that after the sixth day, they enjoy complete immunity.

4. The correctness of the above conclusions was amply proved by experiment at Muktesar, where six bullocks were inoculated by Dr. Kooh in the manner described, and, after the lapse of six days, resisted the disease after being injected with virulent blood taken from animals that were either suffering from, or had died of, rinderpest, and I understood Dr. Kooh to say that he had never known an animal treated according to his method to suffer from rinderpest provided that the process was carried out under proper antiseptic precautions.

5. Dr. Kooh, reasoning on his experience as Bacteriologist, holds a theory which, however, he has not yet worked out by experiment, *viz.*, that the serum of an animal that has been rendered immune and resisted virulent blood, will protect others against rinderpest. The anti-toxin thus obtained should consist of one part of virulent blood to 99 of serum, of which mixture 20 cubic centimetres are injected.

6. With regard to the second paragraph of Inspector General's letter No. 1117-191 M., received under your endorsement above quoted, I have the honour to state that the Ajmere Veterinary School being bounded on three sides by forest preserve in which cattle are not permitted to graze, is, in my opinion, singularly well situated for carrying out experiments in connection with rinderpest, with a minimum risk of conveying contagion to cattle in the surrounding district, and, should the Inspector General, Civil Veterinary Department, desire it, and the Agent to the Governor General approve, I am prepared to take up the work as soon as the necessary material can be procured.

5. Veterinary-Captain Raymond, Superintendent, Civil Veterinary Department, Bengal, was first deputed by the Government of Bengal to Bombay, to consult Professor Koch, and after his interview expressed the following opinion:—

VETERINARY-CAPTAIN RAYMOND'S REPORT.

VETERINARY-CAPTAIN RAYMOND'S REPORT.

"The operations as adopted by Professor Koch, appear to be perfectly simple, but in practice difficulties are likely to confront the untrained at every step: from these causes accidents are already happening in South Africa.

"The preventive treatment only confers immunity about six to eight days after inoculation: during the interval the animal may catch rinderpest.

"It happens that Cattle Plague is latent in the system for about three days before any symptom is noticed. The inoculation with preventive serum in such a case would not prevent the animal suffering or dying of the malady.

"Moreover, it is at least possible that clumsy management by the inoculator may infect a healthy animal with Cattle Plague at the very moment he is injecting the protective serum.

"There can be no doubt that in the Laboratory and in South Africa in skilled hands, Koch's methods are quite successful.

"It remains to be seen if, out here, any modifications are necessary.

"In any case it is desirable to remember that the matter has scarcely got beyond the Laboratory stage, in spite of Press notices and reports."

6. When it was decided that Professor Koch should visit Muktesar, Veterinary-Captain Raymond was again deputed to attend the demonstration: the results following his deputation, and the experiments carried out by him up to date, are contained in the following report, which it is deemed advisable to print *in extenso*:—

In answer to your No. 1537-A of 14th September, which reached this office during my absence on tour, I have the honour to report on the subject of rinderpest as follows:—

1. In paragraph 150, page 14 of my Annual Report for 1896-97, I drew attention to Dr. Koch's experiments in preventive inoculation which he was carrying out in South Africa, and I added, "If it is found to be safe in India, as at the Cape, I purpose to employ this method of experiment."

2. It will be within your recollection that as soon as it was known that Professor Koch had landed in Bombay, the Government of Bengal always solicitous to reduce the great annual losses from rinderpest, deputed me by telegram to confer with him.

3. Upon my reporting that Professor Koch was willing to demonstrate his system, the Bengal Government at once expressed its willingness to defray the expenses.

4. In the meantime, the Government of India had taken the matter into consideration, and Bengal withdrew in favour of the former, the result of the negotiations between the Imperial Bacteriologist and Professor Koch being that the demonstration took place at the Imperial Bacteriological Laboratory at Muktesar, and not in Bengal; all Principals of Veterinary Schools were directed to attend.

VETERINARY-CAPTAIN RAYMOND'S REPORT.

5. While at Muktesar, I saw Professor Koch inoculate several animals with bile and watched the effect, which was confined to the formation of a swelling near the seat of inoculation. No symptoms of disease were shown by the animals.

6. I did not witness any demonstration of the serum treatment.

7. The following is an extract from my letter No. 771 V.D., dated 26th June 1897, which bears upon this subject:—

"Professor Koch's work, though successful in the Laboratory, has still to be studied in its relations to Bengal cattle."

Professor Koch impressed on me that much remains to be done in this direction. If Government is willing, I can easily seek to apply the knowledge acquired.

8. With regard to paragraph 2 of No. 1118—191 M. from the Inspector General, Civil Veterinary Department, which you forward, I have the honour to report that a few experiments have been carried out partly at Belgatchia, and partly in my own garden, and partly at Kanti. There was little danger of rinderpest spreading at the time, for scarcely any cattle came to Belgatchia for treatment, and I had immunised my own cattle. My own garden is completely enclosed.

9. But latterly, the popularity of the Infirmary seems to have increased amongst cattle owners, and there is some risk of infection being carried. I am, therefore, glad to state that Government has under consideration a scheme which will render it possible for experiments to be carried out without any danger to other cattle.

10. I beg to bring to notice some work which I have carried out in connection with rinderpest inoculation.

11. In the month of May, an outbreak of rinderpest was reported from Munshigunge, and I directed my Veterinary Assistant to send me some material from a sick case for experiments. Unfortunately it arrived in such a decomposed condition that the result of an experiment on sick calves was a failure.

12. On the 25th June, a bullock belonging to the Chitpore Municipality was admitted at Belgatchia, suffering from cattle plague and died. The *post-mortem* report is appended (Appendix I).

13. From this animal, two calves were inoculated, but proved to be immune, and as the outbreak was sporadic, my material came to an end.

14. But from the bile collected from the bullock, I inoculated four calves, four bulls, and three bullocks. The dose was 10 c. cm. each.

The result went to prove that the operation was perfectly harmless. The animals had a slight swelling at the seat of inoculation, but they showed no sign of any kind of disease and fed and worked as usual.

15. On the 31st August, I received an urgent telegram from Muzaffarpur. Upon my arrival, I found Mr. G. R. Toomey of the Kanti Indigo concern, who, whilst driving me to his place, told me that cattle plague had been raging on the estate since the 3rd August, and that he had lost 86 head of cattle. I ascertained that some 400

or 500 head of cattle had died in the neighbouring villages. Mr. Toomey had heard that I was desirous of experimenting with rinderpest, and in the most public-spirited manner expressed his willingness to assist me, undeterred by some hostile criticisms of the method which it was my duty to send to him.

16. It should therefore be noted that Mr. G. R. Toomey is the pioneer in India in what may possibly become a very important public benefit. Besides the risk of the loss incurred by Mr. Toomey (for a new thing is always more or less risky), he has refused to recoup himself from the small sum given by Government for experiments, stating that he would rather see the money used for further work.

17. Having decided upon inoculation, the next thing was to procure suitable materials. It was obviously out of the question to kill any of the cattle owing to the religious opinions of the people. On the other hand, observations upon cases that had succumbed during various outbreaks had shown me pretty clearly that the bile was very often unsuitable in cases that had died in the usual way. Unless the bile can be removed at once, it is nearly always useless. Hence there was an element of uncertainty over the work which it was desirable to remove. There is fortunately no prejudice against killing buffaloes. I therefore recommended Mr. Toomey to procure some buffaloes. I there obtained a typical case of cattle plague wherewith to infect the buffaloes. This case (Buffalo A) showed all the symptoms in a marked degree and soon died (for *post-mortem* appearances—see Appendix II).

18. Buffalo No. 1 (see Appendix III) besides receiving material from Bullock A was also treated with material from a young calf that had died without showing all the typical symptoms of cattle plague. Four other buffaloes (Nos. 2, 3, 4, and 5) were also treated with material from Bullock A.

19. Having prepared the way for further work, I returned to Calcutta to my other duties, leaving my Assistant to report by wire when the temperatures of the buffaloes were rising. I returned to Kanti, and on the 3rd September, Buffalo No. 1 was shot (*vide* Appendix III). The bile was extracted and placed in ice. On completion of the *post-mortem* examination, I examined the bile under the microscope, moreover the colour and odour were satisfactory. In the afternoon I injected 10 c. cm. of the bile into each of 12 head of cattle, which were then branded $\frac{K}{T}$ 1-12.

20. On the 5th September, Buffaloes Nos. 2 and 3 were shot (*vide* Appendices IV and V for details). Bile was extracted from both animals, found to be good, and placed in ice. The bile from Buffalo No. 2 was used the same afternoon to inject 28 head of cattle which were branded $\frac{K}{L}$ 1-28.

21. On the 6th September, I injected 32 head of cattle with bile from Buffalo No. 3, which had been kept in ice. This batch was branded $\frac{K}{-}$ 1-XXXII.

22. On the morning of the 7th September, Buffalo No. 4 was shot (for details of temperature, etc., *vide* Appendix VI). I extracted the bile which was good, and placed it in ice. In the afternoon, I injected 21 head of cattle, which were branded $\frac{K}{\square}$ 1-XXI.

23. On the 9th September, Buffalo No. 5 was shot (for details of temperatures, etc., *vide* Appendix VII). From this animal I obtained a quantity of bile, but of the remaining cattle of the herd I only inoculated 14, because some were too wild to catch and others were cows in calf. This batch was branded L K 1-XIV.

From the same animal I secured a quantity of virulent blood for testing experiments. This was placed in ice. Some of the blood and the remainder of the bile was also placed in ice and taken to Belgatchia.

24. I wish here to mention that Mr. Toomey told me that cattle plague had not been known on the estate nor in the neighbourhood for at least eight years and probably more. Mr. Toomey breeds his own cattle. This points to the probability that none of the animals on the estate had been rendered immune against cattle plague by suffering from a previous attack.

25. It was found impracticable to take the temperature of the 108 cattle that had been treated with bile, but they were all repeatedly inspected by Mr. Toomey, his Assistant, my Assistant, and myself, and I was surprised to see how little swelling was to be seen: only in two cases did it interfere with the gait of the animals. Constitutionally none of the animals appeared to suffer in the slightest degree.

26. Professor Koch states that the bile injection confers immunity not later than the tenth day.

27. In order to test the immunity of the animals after the bile treatment, 6 bullocks were selected simply because they were blind or lame—

(*a*) bullocks $\frac{K}{T}$ 2 and 10 each received subcutaneously 20 c. cm. of virulent blood from Buffalo No. 5 on the 17th September, that is to say, seven days after the bile inoculation (see Appendices VIII and IX);

(*b*) bullock $\frac{K}{L}$ 15 received subcutaneously 10 c. cm. of virulent blood from Buffalo No. 5 on the 12th September, that is to say, after seven days after bile inoculation (see Appendix X);

(*c*) bullock $\frac{K}{L}$ 16 received 20 c. cm. at the same time, under the same circumstances (see Appendix XI);

(*d*) bullock $\frac{K}{L}$ 1 (Appendix XIII) received 10 c. cm. of virulent blood from a case of Belgatchia (*vide* Appendix XII) on the 16th September, that is, eleven days after inoculation with bile.

(*e*) $\frac{K}{L}$ 2 received 20 c. cm. of the same blood on the same date and under the same conditions (*vide* Appendix XIV).

All these animals proved to be immune.

Immunising Cattle against Rinderpest. | **OXEN.**

VETERINARY-CAPTAIN BAYLIS'S REPORT.

28. The dose of virulent blood used in these test cases is said by Koch to be respectively 5,000 and 10,000 times greater than a fatal dose.

29. The experiments above recorded go to show that Professor Koch's preventive treatment with bile promises to be successful in Bengal. The exact amount of success can only be determined by future experiment.

30. Here again Mr. G. R. Toomey has rendered great assistance by permitting the inoculated bullocks to be branded, so that each animal might be identified later.

31. I have performed another experiment to ascertain if by any chance bile in this province would confer immunity quicker than in other climates. For this purpose I injected calves with 10 c. cm. of bile and five days later tested them with virulent blood from Buffalo No. 5. They have all re-acted in temperature, three developed genuine rinderpest, and one died.

32. Experiments are proceeding.

APPENDIX I.

Post-mortem appearances.

Gall Bladder—was full containing a greenish fluid of a peculiar mild colour.

Lungs—were congested and emphysematous, which are the most characteristic points in the disease rinderpest.

Trachea Larynx and Bronchial tubes—were merely congested with an ulceration close to the vocal chords in the Larynx.

Buccal and Schniederian membrance—were almost all right, but patches of congestion here and there.

Rumen, Reticulum, Omasum and Abomasum.—There was congestion in the first stomach which is generally not found. The fourth stomach was highly congested and had a tendency of throwing off the mucous membrane.

Large and small intestines—were exhanthamatous and infiltrated, but there was hardly any ulceration.

Heart, Liver and Kidneys—were almost normal.

APPENDIX II.

Post-mortem appearances of Bullock A, died of Rinderpest at Kanti on the 29th August 1897.

Mouth—normal.

Pharynx—congested, bran-like deposit on the side of the Epiglottis.

Larynx and Trachea.—The former was congested with ecchymosis and the latter congested.

Lungs—Emphysematous, anterior tubes congested.

Stomachs—Rumen, Reticulum and Omasum normal: Abomasum highly congested and discoloured with erosions and croupous membrane and the mucous membrane thickened.

Intestines.—Small intestines congested with ecchymosis, croupous membrane, ulceration of Peyer's patches, mucous membrane thickened in places. Large intestines congested in patches and casts. Rectum congested in patches and stripes.

Spleen and Liver—normal, and Gall Bladder contained clear bile.

Kidneys—slightly congested.

Bladder—congested, with a few spots of ecchymosis.

APPENDIX III.

DISEASE.

Rinderpest.

Notes of Case.

Name { *Buffalo Calf.*

Case Book No. 1.

Infected from Bullock No. "A" also from a Cow-calf which died showing the typical signs of Rinderpest, on the 27th. August 1897.

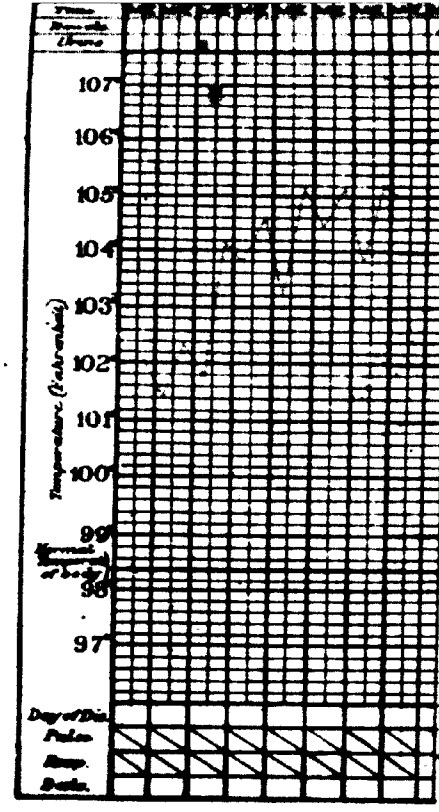
Provided bile with which $\frac{K}{1-12}$; 12 heads of cattle were injected.

Dose.—10-c. c. m.

Date of Inoculation.

27th. Aug. '97 at 1-30 P.M.

Result.—Shot 3rd. Sept. 1897.



Post mortem appearances of Buffalo No. 1 fed on dung and blood from Rinderpest and destroyed on 3rd September 1897.

Mouth.—Erosions on Gums.

Larynx and Trachea.—Very slightly congested, otherwise normal.

Lungs.—Slightly Emphysematous.

Heart.—Normal.

Stomachs.—First three stomachs normal, and the last one congested, and mucous membrane thickened.

Intestines.—Small intestines congested with mucous membrane thickened and corrugated. Large intestines congested, and Rectum congested with streaks, and mucous membrane thickened and corrugated.

Spleen
Liver
Bladder } Normal.
Kidneys

APPENDIX IV.

DISEASE.

inderpest.

Notes of Case.

ame { *Buffalo.*

Case Book No. 2.

Inoculated from Bullock a. "A" suffering from inderpest on the 29th. ugust, 1897.

Provided bile with high $\frac{K}{T}$ 1 to 28.

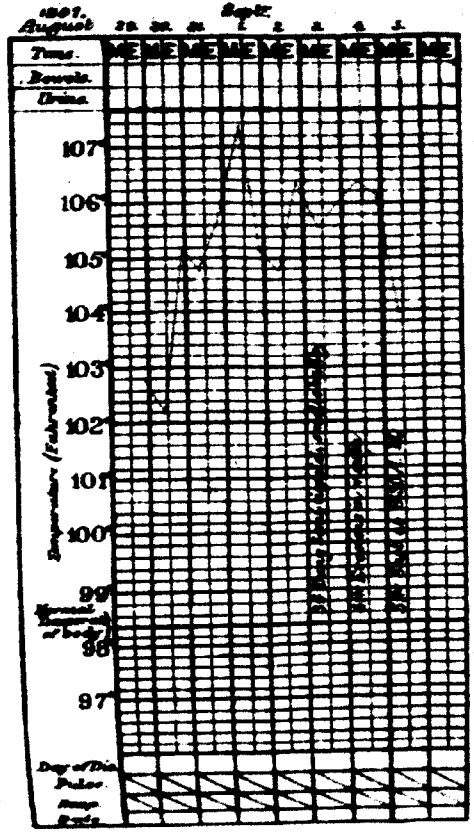
28 Heads of cattle are infected.

Dose.—10-c. cm.

Date of Inoculation.

30th. Aug. '97 at 1-30 P.M.

Result.—Died, 5th. Sept. 1897.



Post Mortem Appearances of Buffalo No. 2.

Mouth.—Erosions.

Tongue.—Erosions and bran-like deposits on both sides.

Larynx.—Congested with ecchymatic spots on Epiglottis.

Trachea.—Congested with large ecchymatic spots.

Lungs.—Slightly emphysematous and congested in patches.

Heart.—Endocardium congested and pericardium slightly congested at apex.

Stomachs.—First three stomachs normal and abomasum congested with petechial patches.

Intestines.—Small intestines congested, in some parts with mucous membrane thickened, Peyer's patches congested, croupous membrane in some parts and in others yellowish tinge. Large intestines erosions in cæcum with fibrinous casts.

Kidneys and Liver.—both slightly congested.

Bladder.—Slightly congested with ecchymosis.

Spleen.—Normal.

APPENDIX V.

DISEASE.

Rinderpest—

Notes of Case.

Name { *Buffalo.*

Case Book No. 3.

Infected from Bullock "A" suffering from Rinderpest on the 29th. August 1897.

Bile taken for injection.

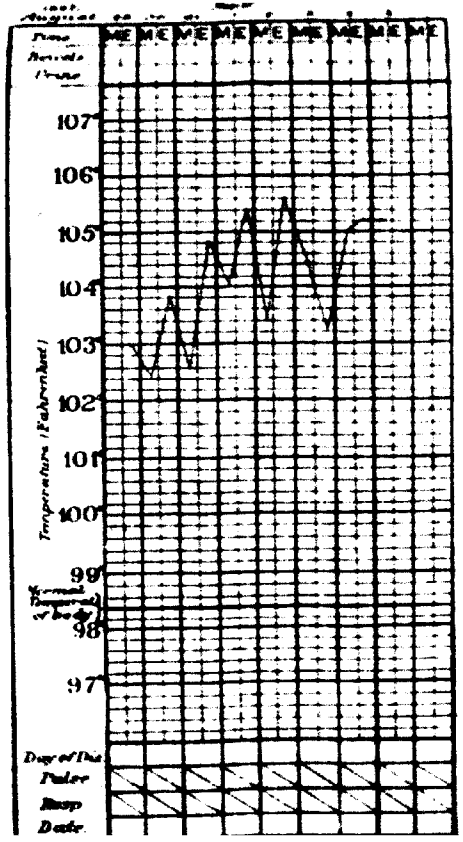
Not used on same day.

Injected 32 heads of cattle on the 6th. September 1897 at Dumuria.

Date of Inoculation.

29th. Aug. '97 at 1-30 P. M.

Result.—Destroyed at 8 A. M., on the 5th. Sep. 1897.



Post mortem appearances of Buffalo No. 3, fed on dung and blood from a case of Rinderpest, and destroyed on the 5th September 1897.

Mouth, Tongue, Pharynx, Larynx, and Trachea.—Normal.

Lungs and Heart.—Lungs emphysematous and slightly congested and the latter normal.

Stomachs.—All stomachs normal except abomasum, which was congested and the mucous membrane thickened.

Intestines.—Small intestines congested with occasional patches of ecchymosis near the Ilio-Cæcal valve and the mucous membrane thickened and corrugated.

Bladder.—The fundus of Bladder slightly congested.

Spleen, Kidneys, and Liver.—were all normal, but the mucous membrane of Gall Bladder was slightly congested.

APPENDIX VI.

DISEASE.

Rinderpest.

Notes of Case.

Name { *Buffalo.*

Case Book No. 4.

Infected from Bullock "A" with Rinderpest on the 29th. August 1897.

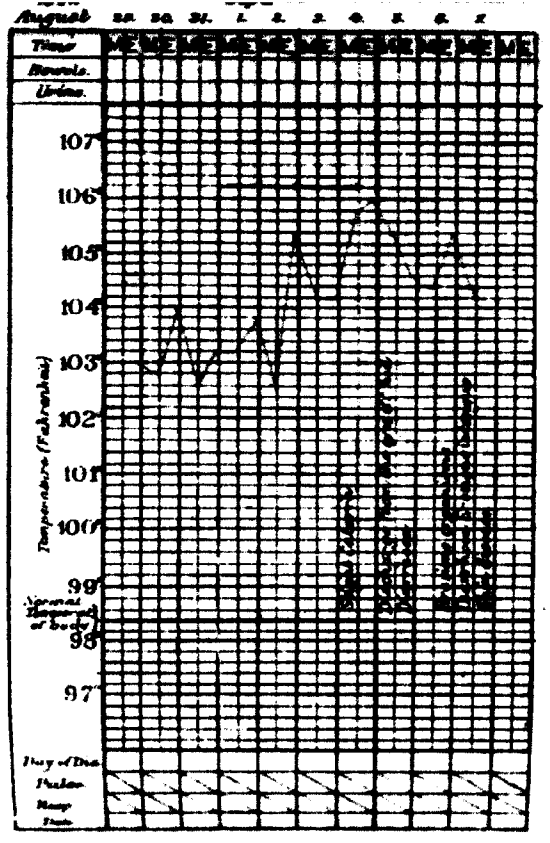
Bile taken and injected into 21 heads of cattle at Dumuria at 4 P. M. of the 7th. September 1897.

Serlo.—K 1-xxi.

Date of Inoculation.

29th. Aug. '97 at 1-30 P.M.

Result.—Destroyed at 7-30 A. M., on the 7th. Septr. 1897.



Post mortem appearance of Buffalo No. 4 fed on dung and blood from a case of Rinderpest, and destroyed on the 7th September 1897.

Mouth.—Erosions.

Pharynx.—Erosions with brany deposits and gelatinous effusions

Larynx and Trachea.—Normal.

Lungs.—Congested and emphysematous.

Heart.—Normal.

Stomachs.—Only the last stomach congested and the mucous membrane thickened.

Intestines.—Small intestine congested with croupous membrane, cæcum was congested with numbers of croupous membranes. Large intestines were exanthamatous with fibrinous casts and Rectum with stripes and patches and the mucous membrane thickened.

Spleen and Liver.—Normal, and Gall Bladder venous congested the mucous membrane thickened with petichea.

Kidneys.—Slightly congested with serous effusion in and around.

APPENDIX VII

DISEASE.

Rinderpest.

Notes of Case.

Name { *Buffalo.*

Case Book No. 5.

Infected from Bullock "A" with Rinderpest on the 29th. August 1897.

Enough bile was found for about 40 injections, but only 14 were injected at Dumuria.

Series.—L K I—xiv.

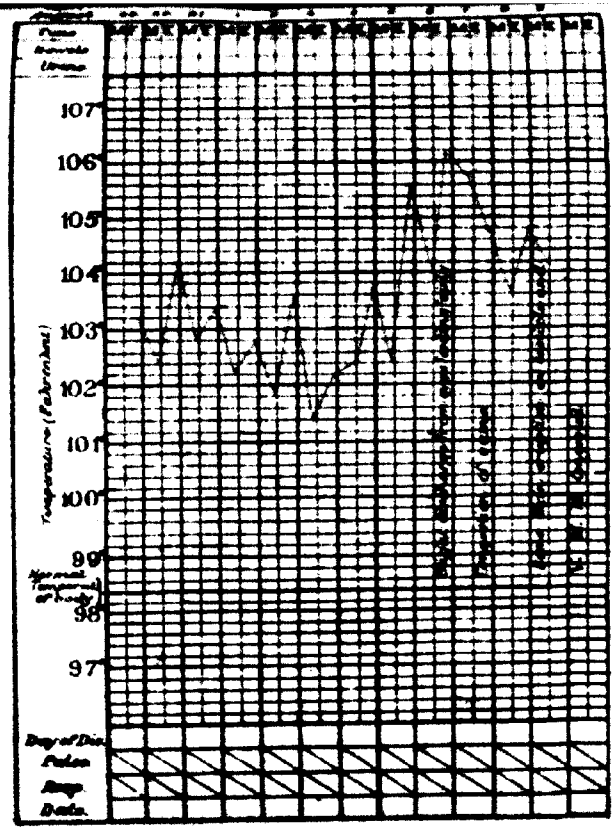
Blood was taken and injected on 10th. at 8A.M. into Bullocks $\frac{E}{I}$-2 & 10 as tests.

Dose.—20-c. c. m.

Date of Inoculation.

29th. Aug. '97 at 1-30P.M.

Result.—Destroyed at 9 A.M., on the 9th. Sept., 1897.



Post Mortem Appearances of Buffalo No. 5, fed on dung and blood of Rinderpest.

Skin.—Eruptions around the teats and perinæum emphysema of subcutaneous areolar tissue.

Mouth.—Normal.

Pharynx.—Slight brany deposit.

Larynx and Trachea.—Normal.

Lungs.—Emphysematous and congested anteriorly.

Heart.—Ecchymosis on the endocardium of left ventricle.

Stomachs.—First three stomachs Normal and the fourth one considerably congested and thickened with 2 big erosions.

Intestines.—Small intestines congested and yellowish in places. Mucous membrane thickened and Peyer's patches enlarged. Cæcum and large Colon slightly congested with streaks. Single Colon normal. Rectum slightly congested with stripes.

Liver.—Congested and gall Bladder congested with ecchymatic spots.

Spleen and Bladder.—Normal.

Appendix VIII

Test inoculations

DISEASE

Rinderpest

Notes of Case.

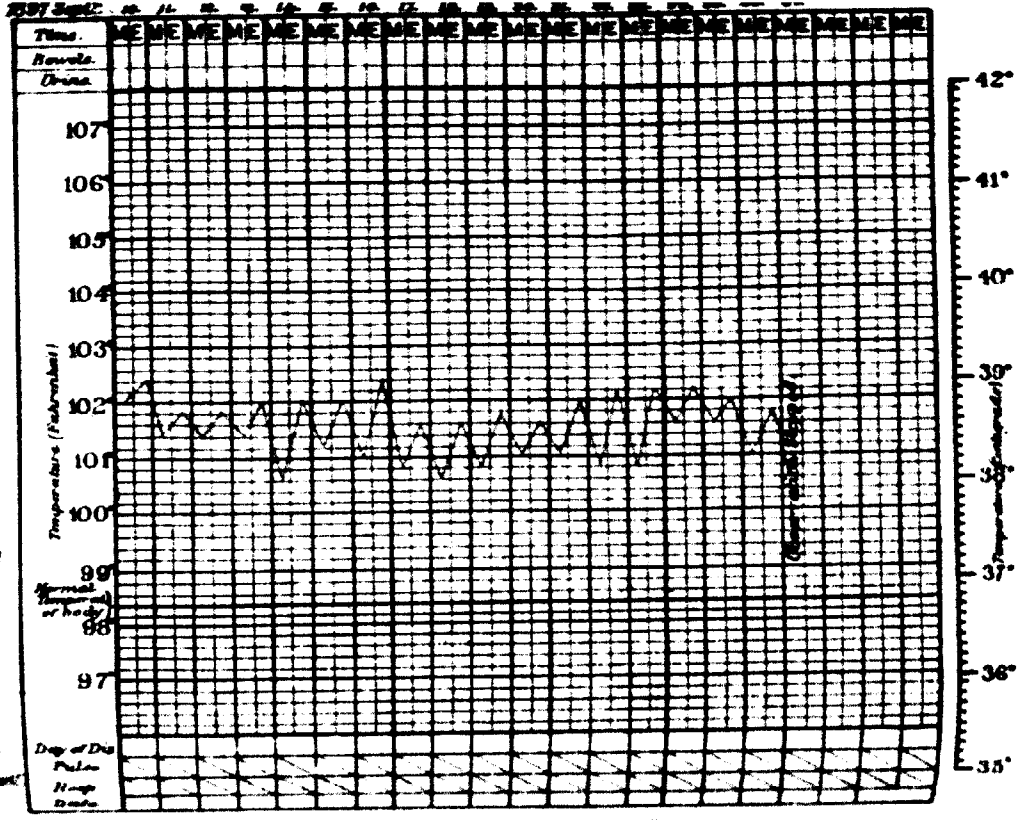
Name { K / I / 2

Was inoculated with 10 c. cm bile from Buffalo N° 1 on the 3rd September 1897

Received on 10th Sept. 20 c. cm of defibrinated virulent blood from Buffalo N°8.

7th day.

Date of inoculation.
1st 3rd Sept. 2nd 10th Sept.
Result. Immune.



Appendix IX
Chart illustrating

DISEASE

Rinderpest.

Notes of Case.

Name { K / R / Bo

Bullock

Was inoculated with 20 c. cm. bile from Buffalo № 1 on the 8th September 1897

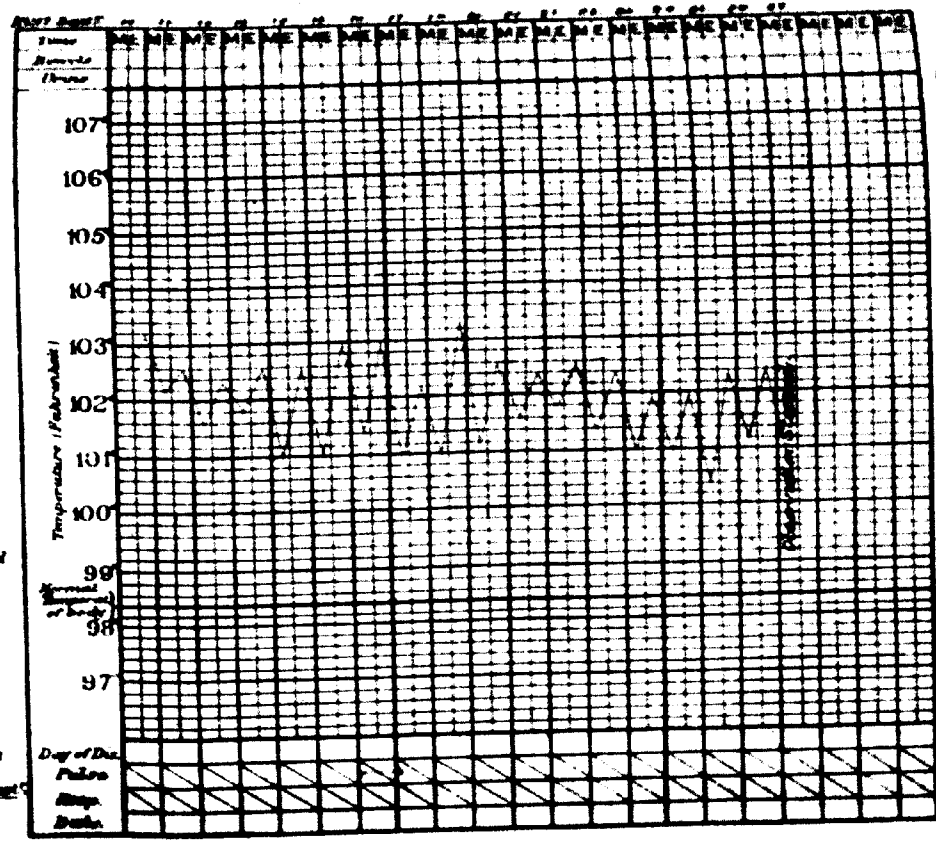
Received on 10th Sept. 20 c. cm. of defibrinated virulent blood from Buffalo № 5.

7th day.

Date of inoculation

Date [illegible]

Result, Immune



Appendix x

Test inoculations

DISEASE

Rinderpest.

Notes of Case.

Name { K / L / M

Bullock

Was inoculated with 10 c. cm. bile from Buffalo No 3 on the 5th September 1891.

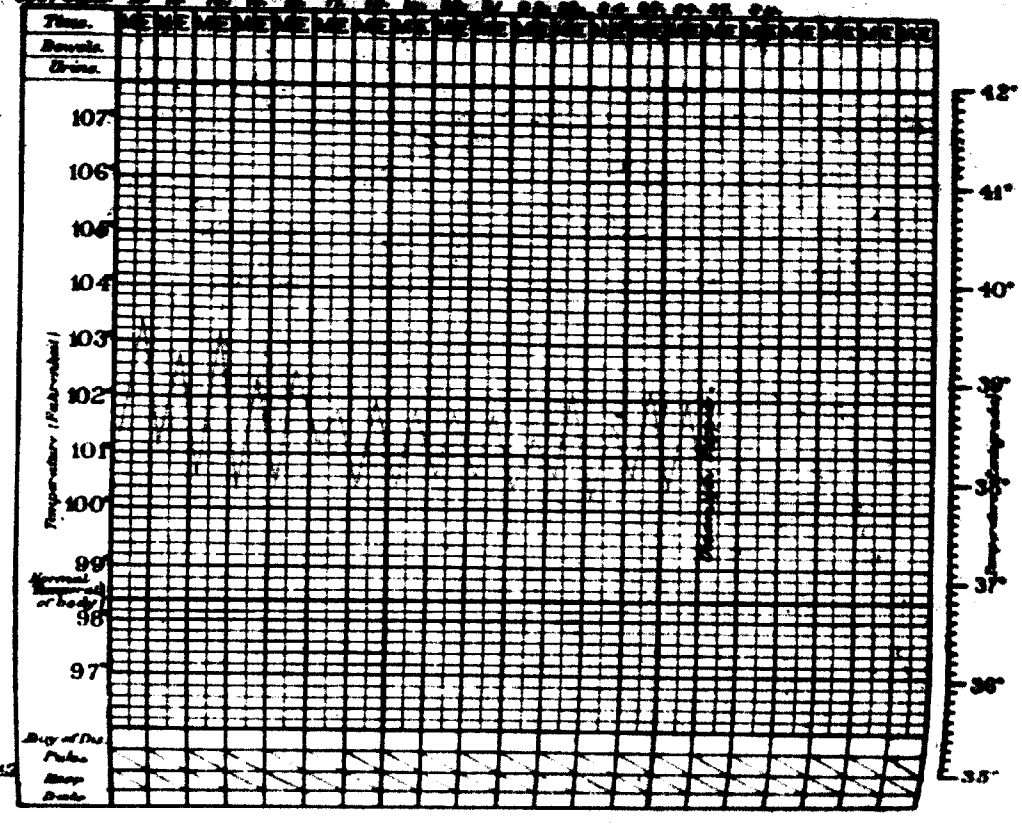
Received injection. Subcutis on 12th Sept. 10 a.m. cm blood from Buffalo No 5.

1st day.

Date of inoculation

Bullock Small Blood 12 Sept.

Periods. Invasion.



Appendix [illegible]
Post mortem [illegible]

DISEASE

Rinderpest

Notes of Case.

Name { K / L / 16

Bullock

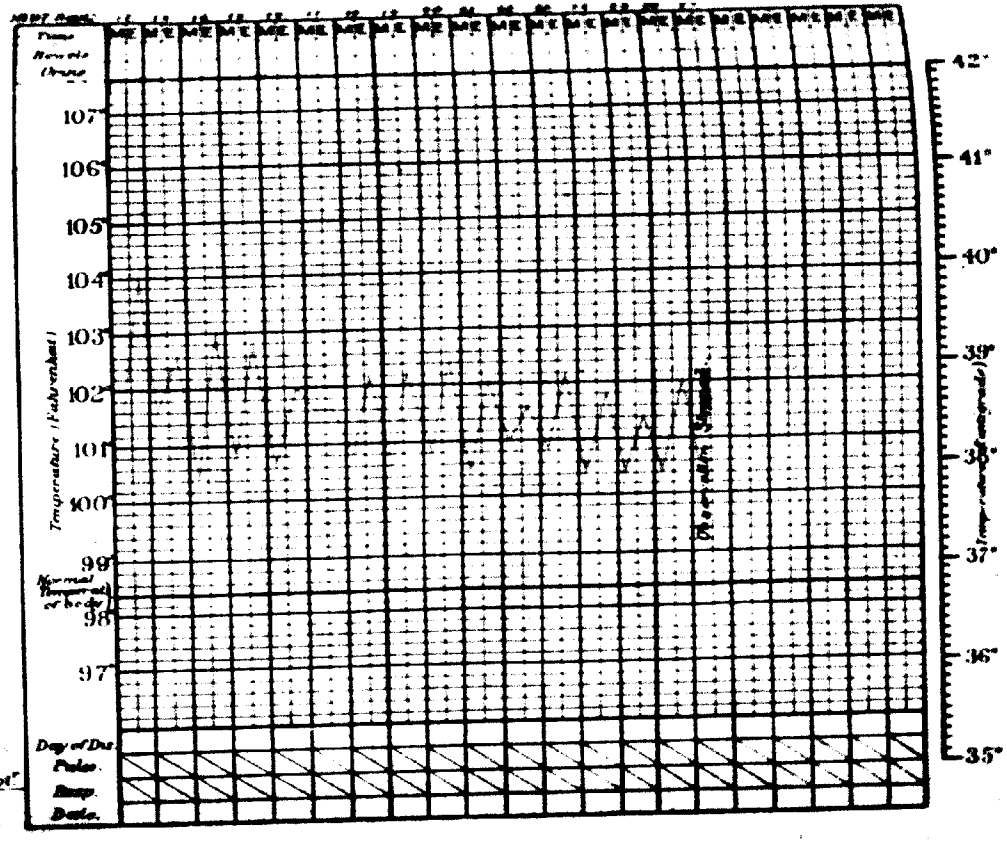
Was inoculated with 20 c cm bile from Buffalo N°3 on 5th September 1897

Received subcut 40 c cm V Blood from Buffalo N°5 on 12th Sept[r] 1897. 7th day

Date of inoculation

Bile 5th Sept[r] Blood 12th Sept[r]

Result. Immune



VETERINARY-CAPTAIN RAYMOND'S REPORT.

APPENDIX XII.

Post-mortem appearance.

Mouth—Excoriation of Buccal membrane, hard palate, dental pad, inside cheeks, lower lip, gums, under surface of tongue, soft palate and throat: the latter was much congested and discoloured.

Pharynx—congested and claret-coloured and excoriated.

Larynx and Trachea—living membrane congested and discoloured in patches.

Heart—Pericordium discoloured in patches: Endocardium marked with spots of ecchymosis.

Lungs—both congested, particularly the right one, and emphysematous.

Liver—clay-coloured and somewhat enlarged.

Gall Bladder—mucous membrane marked with patches of congestion.

Kidneys—both congested.

Spleen—also congested and somewhat enlarged.

Abomasum—very much congested, the anterior half being of a leaden hue and the posterior claret-coloured with excoriation and patches of extravasation.

Omasum—Epithelium easily peeled off, etc., and the blood vessels enlarged.

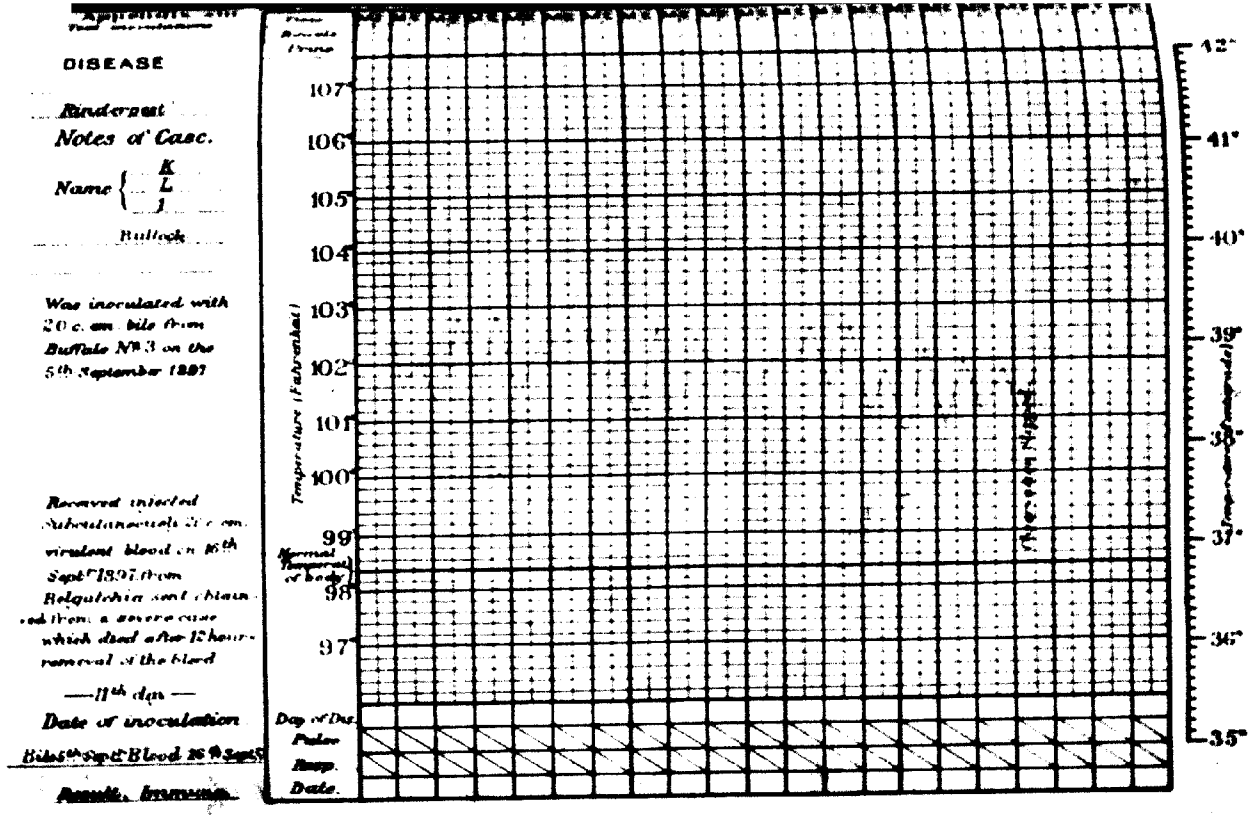
Reticulum—mucous membrane congested and its epithelium easily removeable.

Rumen—Epithelium easily removeable and it contained a large quantity of omphystoma Coimcum.

Small Intestine—contents were liquid, with large amount of viscid mucous and shreds: mucous membrane congested and marked with numerous patches of extravasation and several of the Peyer's patches ulcerated.

Large Intestine—mucous membrane congested in patches of scarlet colour and the contents were liquid with a large quantity of mucous castings and shreds.

Rectum—congested in patches and streaks.


DISEASE
Rinderpest
Notes of Case.
Name { K L J
Bullock
Was inoculated with 20 c.cm. bile from Buffalo N°3 on the 5th September 1897
Received injected Subcutaneously 2 c.cm. virulent blood on 16th Sept 1897 from Belgutchia and obtained from a severe case which died after 12 hours removal of the blood
—11th day—
Date of inoculation
Bile 5th Sept Blood 16th Sept
Parasite. Immunity.
Temperature (Fahrenheit)
Normal Temperature of Body
Afternoon Visits
Day of Dis.
Pulse
Resp.
Date.
107
106
105
104
103
102
101
100
99
98
97
41°
40°
39°
38°
37°
36°
35°

Appendix XIV
Test inoculations

DISEASE

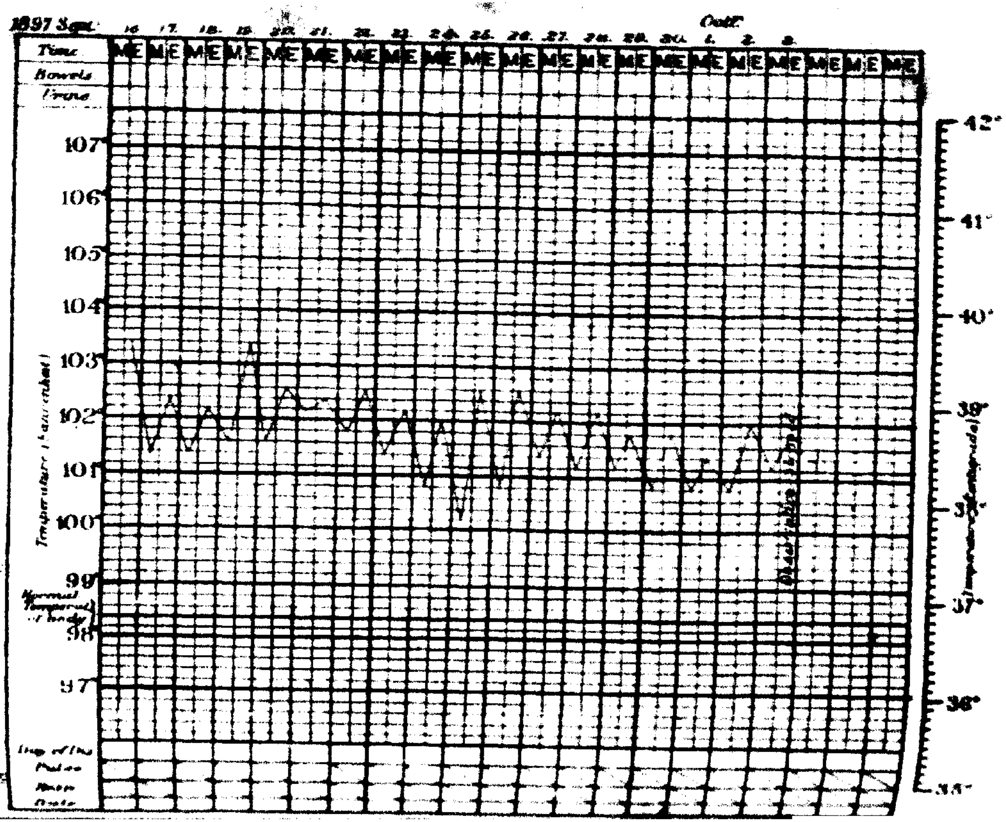
Rinderpest
Notes of Case.

Name { K. L. 2

Bullock.

Was inoculated with 10 c cm bile from Buffalo No. 3 on the 5th September 1897

Received injected subcutaneously 1 c cm virulent blood on 16th Septr. 1897 sent from Belgatchia and obtained from a severe case of Rinderpest which died 12 hours after removal of the blood. — 11th day — Date of inoculation 5th Septr. Blood 16th Septr. Remarks. Immune.



Immunising cattle against Rinderpest. OXEN.

REPORT OF VETERINARY-CAPTAIN EVANS.

REPORT OF VETERINARY-CAPTAIN EVANS.

REPORT of VETERINARY-CAPTAIN EVANS.

7. **Veterinary-Captain Evans**, Superintendent, Civil Veterinary Department, Burma, after carefully describing the various methods adopted by **Professor Koch**, states :—

"In conclusion, from what I have said, it may be gathered that I consider trying experiments here, on the little experience I gained at Muktesar (and which in my opinion were not altogether a success), inadvisable. I feel convinced that **Professor Lingard** will obtain fresh virus and conduct further experiments. If successful, it will be time enough to begin here, I do not wish (unless ordered) to engage in any experiments until such time as I am satisfied that I may reasonably expect good results.

Professor Lingard at the Laboratory is, I fancy, the person best calculated to conduct experiments which are likely to afford the required information, as he has the time and facilities. I am strongly of opinion that it would be a great pity to be in too much haste to try experiments here which might end in failure, and thus cause the Burmans to lose all confidence in them, which would most assuredly be the case. When I hear that the protective method is successful, I have little doubt as to my ability to introduce it quietly, and in a short time to gain the confidence and assistance of the Burmans, in carrying the system out."

VETERINARY-LIEUTENANT BALDREY'S REPORT.

VETERINARY-LIEUTENANT BALDREY'S REPORT.

8. Veterinary-Lieutenant Baldrey, Assistant Principal, Bombay Veterinary College, makes the following remarks, after careful consideration of the methods adopted by Professor Koch:—

After inoculation with rinderpest blood, the temperature in four days goes to 104: then rinderpest evinces the usual symptoms. As far as I can see from personal observation, this system cannot be pronounced as an absolute certainty. One animal that I saw immunised, contracted a mild form of rinderpest when inoculated with virulent rinderpest blood, and I think that a great number of animals should be tried in different parts of the country, before going any further than to say that this system is any more than experimental. Up to now there is nothing to guide us in proving how long the immunity lasts: and this is a matter which would take at least two or three years to prove: an immunity of a few months would be of no practical value. An attack of rinderpest from which an animal has recovered, is known to produce a certain degree of immunity, but animals have been known to get the disease two or three times and even then die. I think it essential that some experiment should be tried in the Plains—say at the various Veterinary Schools—under systematic isolative precautions, as the climate is very different to Muktesar, which is at an elevation of 7,700 feet; and a variety of conditions are necessary to prove its invariable efficacy.

Up to now these experiments in India are Laboratory ones, in a favourable climate and under the most favourable conditions, so I think it necessary that something should be done in the Plains, and that animals should be exposed to all sorts of infection, such as they would meet with in the ordinary way: as it does not follow that if an animal is immune, against virulent blood, that it will also be immune to the infection that an infected herd would create, as it has been found in the case of Anthrax. It will be seen that an outbreak of rinderpest is absolutely essential to the carrying out of preventive inoculation, and that the bile from one dead rinderpest animal cannot be relied upon to do more than 10 (ten) animals, and that unless the inoculation be carried out by thoroughly competent men, it is more than probable that instead of rendering immunity, fresh centres of infection would be set up. I have said earlier in my report that the bile must be taken not later than seven days. This is because the duration of the disease, from the rise of temperature, is only seven days; if an animal lives longer than that, it has overcome the disease itself, so that it is very doubtful if bile taken after the seventh day, would be of use. This also requires experiments. I may briefly here explain how it is that rinderpest blood produces the disease, as they—both bile and blood—undoubtedly contain the poison of rinderpest. It is thus:—

"Blood when injected is immediately absorbed into the blood circulation in an unaltered condition, producing practically no inflammation at the seat of inoculation, and therefore causes the disease.

"Bile when inoculated, immediately causes inflammation, and consequent swelling: this swelling, which is as large as a child's head, inhibits the power of surrounding blood vessels and lymphatics to absorb the poison, and the action of the animal secretions in the affected part, have such an effect on the poison, that it loses its power to produce the disease but retains sufficient vitality to produce immunity. Bacilli of all kinds may occasionally be found in the bile, but this is accidental; they having found their way in from the intestine. None of these bacilli have yet been found to be rinderpest: they are ordinary putrefactive germs. No bacillus of rinderpest has as yet been isolated.

"Professor Koch has shown that the infection is carried a very short distance by flies (only the width of the standing room occupied by six or seven cows) and that cows will not get it in one end of an ordinary stable when diseased animals are standing in the other end. Actual contact seems essenual, but infection by litter, discarded food, the boots and clothes of attendants, is conveyed to any distance and for any length of time."

G. I. C. P. O.—No. 1415 R. & A.—5-7-98.—2225—P. M. M.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be classed according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

Each part and the title-page may be removed when the subject-matter is filed in its proper place according to the letter and number shown at the bottom of each page.

NOTICE.

Future issues of this publication placed under either the "Special Veterinary" or "Special Forest Series" will not be included in the annual enumeration. Such papers are printed for Departmental purposes. Their unfortunate inclusion in the system of annual numbering has led recipients of the ordinary issues to find their sets incomplete.

The following pamphlets have already appeared as Special issues, and have not accordingly been furnished to the public:—

1894 . . . Nos. 8, 9, 10, 11, 13 and 15.
1896 . . . No. 8.